Vol. 11 AUGUST, 1928 No. 8

Journal

of the

American Ceramic Society

Abstracts Bulletin

A Monthly *Journal* Devoted to the Arts and Sciences
Related to the Silicate Industries

Publication Office: 450 Ahnaip St., Menasha, Wis.

Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on Publications: F. K. PENCE, *Chairman;* W. E. DORNBACH, F. C. FLINT, M. L. HARTMANN, ROSS C. PURDY.

Entered as second class matter at the post office at Menasha, Wis. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, section 412, P. L. and R. authorized January 29, 1926.

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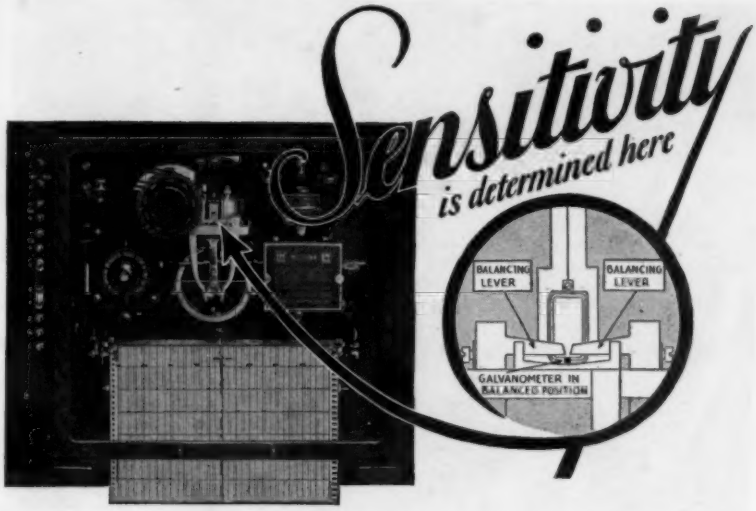

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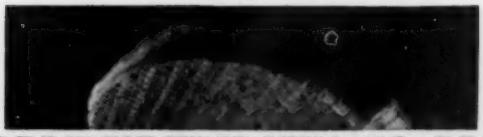

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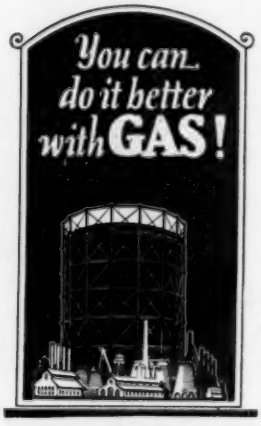

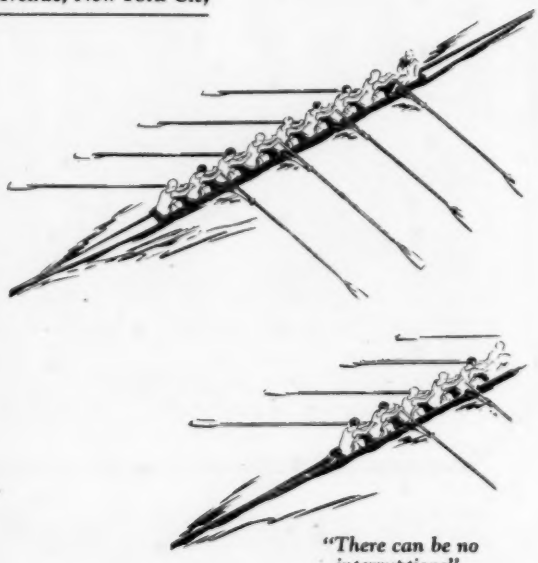

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PROGRESS REPORT ON CAST IRON FOR ENAMELING PURPOSES[1]

By W. N. Harrison,[2] C. M. Saeger, Jr.,[3] and A. I. Krynitsky[4]

ABSTRACT

Blisters on enameled cast-iron ware may be traced either to faulty enamels and process of application or to the castings themselves. This investigation is concerned with the latter type of blisters. Differences in the blistering tendencies of different sets of castings were clearly brought out by an enameling test which included a variety of firing treatments. Using this test it was found that not only do different irons have different blistering tendencies, but successive heats of the same iron may have different blistering tendencies. The main source of blisters from the irons used in this work was overcome by removal of a thin surface layer of the castings, through either mechanical or chemical means.

Introduction

In the application of vitreous enamels to cast iron, it is a common occurrence for gas to be evolved during the firing period. When the evolved gas escapes without leaving any noticeable trace no harm is done, but when bubbles and craters mar the surface of a processed article, it must be either scrapped or reprocessed after removing the enamel. Such defects, ordinarily referred to as blisters by enamelers, may originate from faulty enamel or improper procedure in application. On the other hand, with a given enamel and process of application, there is a marked difference in the tendency of different castings to give blistered ware when enameled. Thus two different castings after leaving the molds may be cleaned by identical treatments, coated with the same enamel, and fired side by side in the same furnace, only to give widely different results. One piece may be perfect and the other badly blistered. Usually two such castings will be from different heats of iron or from irons of different types. It is this latter kind of blistering, for which the iron is in some manner responsible, which is the subject of the present investigation.

When the work was begun it was the opinion of some enamelers that northern irons caused blistering while southern irons did not. The use of southern iron had become less economical, however, through advances in freight rates, which are particularly effective because of the long haul necessary for the majority of manufacturers to obtain southern iron. A widely used and allegedly effective means of rendering

[1] Publication approved by the Director of the Bureau of Standards of the U. S. Department of Commerce, Washington, D. C. Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Enamel Division.) Received April 7, 1928.

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northern iron serviceable was the inclusion of a substantial percentage of scrap iron or remelt in the cupola charge; but for various reasons, among which was the relative scarcity of scrap iron, this remedy was not considered as a solution of the problem. Hence the Bureau was requested to make a study of cast iron for enameling purposes, with the object of determining the causes and control of the tendency of some castings to produce blisters.

The investigation has been conducted on an extensively coöperative basis. Within the Bureau of Standards the Ceramics and Metallurgy Divisions have collaborated on the investigative work, and the Chemistry Division has made a large number of analyses. The AMERICAN CERAMIC SOCIETY, through the Research Committee of the Enamel Division, has been in constant coöperation with the Bureau, and a number of manufacturers have contributed in one or more forms to the investigation.

Brief History of Investigation to Date

In describing the progress of this investigation no attempt will be made to go into the details of all the leads which have been followed, but rather an outline will be given, with fuller description of those tests which have definitely advanced the work. Some idea of the space which a detailed history would occupy may be obtained from the fact that considerably more than 200 microscopic examinations have been made; analyses of over 70 samples, involving more than 350 individual determinations have been carried out; and well over 2000 specimens cast, most of which have been enameled and the procedure carefully controlled and recorded. For convenience the present report of the work will be divided into several periods or stages, corresponding approximately to several different general methods of attack.

Initial Experiments Before the necessity for an organized research program was decided upon, a few preliminary tests were made. A number of enamelers sent to the Bureau iron castings, some of which were said to give serious trouble in the form of blisters, while others could be enameled satisfactorily. These samples of "poor" and "good" iron were given chemical and metallographic analyses, but the results did not indicate any satisfactory means of distinguishing between the two.

Coöperative Organization of Investigation Subsequent to these preliminary tests arrangements were made for the Bureau to work on the problem, using iron furnished by representatives of the AMERICAN CERAMIC SOCIETY and employing a procedure agreed upon by the Bureau and the Research Committee of the Enamel Division. This plan provided for the casting

of specimens and their metallographic examination by the Metallurgy Division of the Bureau, the chemical analysis by the Chemistry Division, and enameling experiments by the Ceramics Division. The enameling properties were also to be tested in a number of plants, using a variety of commercial procedures. These included dry-process enameling at low, medium, and high temperatures, wet-process with ground coat, and wet-process without ground coat.

Variables First Studied

The variables in iron which were first studied included the effects of repeated meltings, different sources of iron and the addition of various ingredients in the cupola and in the ladle. For instance, the presence of arsenic in southern iron, and tin in scrap iron, led to the suggestion that these ingredients might be responsible for the good enameling qualities of scrap and southern iron, and these elements were therefore added to some melts. Later either sulphur or manganese was added to some melts to bring the ratio of these elements to that which had been found in several "good" heats of iron. In addition, attempts were made to reduce the amount of carbon present on the surface of the iron. Plates were coated with Fe_2O_3 and annealed to oxidize the graphite; plates were also treated with a decarbonizing brazing compound and annealed for the same purpose. Tests were made on coke iron and charcoal iron.

Results of First Experiments

Not all of these variations were represented in the samples sent out to be enameled by the coöperating manufacturers, but a number of them were, especially the different melting charges. After several groups of plates had been sent out to the various manufacturers, and duplicates of each set enameled at the Bureau, it was impossible to draw any definite conclusions from the results. As an example of the inconsistent data which were obtained, the results from one set of experiments will be cited. In this case sixteen specimens, including castings from eleven different melting charges, were sent to each of five manufacturers for enameling, and duplicates were also enameled at the Bureau. One company returned all samples without blisters; three companies, using enamels of approximately the same fusibility, checked moderately well in distinguishing between blistering and nonblistering castings. One company enameled over half its specimens and obtained blisters on every piece, then changed the firing practice and eliminated blisters from all the rest of the samples. The Bureau obtained blisters on iron from only one melting charge. There were, however, several factors which appeared at that time to be related to the enameling properties of the irons. One of these was the sulphur-manganese ratio and another the physical soundness of the castings.

Plan of Attack Changed

With results as typified above, the solution of the problem appeared but little closer. When they were reported to the coöperating committee, it was decided that the variation in enameling practices encountered at the different factories had too much effect upon results, and that the test specimens therefore should be enameled at the Bureau by a standard procedure. This procedure was accordingly worked out at the Bureau in coöperation with a representative of the AMERICAN CERAMIC SOCIETY, using a supply of ground coat and cover coat frits which was furnished the Bureau by the coöperating committee, the compositions of which are shown in Table I. Each process in the application was controlled so that no blisters were obtained when the enamel at hand was applied over castings which had been supplied the Bureau as non-blistering iron.

Using this standard procedure, some of the previous results were checked over and the findings did not indicate that any benefit was derived from repeated meltings of the iron or from additions of sulphur or manganese to adjust the ratio to a definite figure. There was some indication, however, that a relatively high pouring temperature was beneficial, and this led to the suggestion that the fluidity of the melt at the time of pouring, through its effect on the soundness of the castings, was an important factor. The study of fluidity represents an investigation in itself and is still in progress.

To improve the physical soundness of the castings, the system of preparing specimens was changed, as it was recognized that spongy castings or slag inclusions could very readily cause blistering and pinholing and had heretofore led to some of the confusion in interpreting results. Whereas previously four separated specimens had been cast in a single mold, the new method was to cast a single plate from which eighteen specimens could be cut. Thus most of the specimens were not directly connected with a gate, and were consequently sounder and freer from dirt. In general no facings were used, but in one series of tests, for the purpose of comparison, a number of different facings were used. These included silica flour, ethylene glycol, silica flour suspended in ethylene glycol, glycerine, wheat flour, and plumbago. Of these the silica flour appeared to be conducive to fewest blisters, but could not be considered a satisfactory remedy.

A new heat of iron was made in an attempt to duplicate a previous heat which had given blister-free pieces, but blisters were obtained on castings from the new heat when enameled. An inconsistency of this sort occurring again after the introduction of the standard enameling procedure served to cast the shadow of uncertainty over all the data which had been obtained up to that time. This latest development

brought seriously into question whether or not blistering was due entirely to factors, controllable or otherwise, introduced in the enameling process, and independent of the iron. It then became necessary to determine whether or not this was the case, and to develop an enameling test which would definitely show any considerable difference in the enameling qualities of various irons, if such difference existed.

TABLE I

STANDARD GROUND COAT AND COVER COAT

Raw Material	Batch Weights Ground coat	Cover coat	Ingredient	Melted Weights Ground coat	Cover coat
Feldspar		34.70	SiO_2	67.40	14.30
Quartz	67.40	14.30	B_2O_3	17.04	8.91
Borax	37.10	24.30	Na_2O	8.35	7.13
Red lead	7.35	16.05	PbO	7.16	15.70
Boric acid	6.07		Feldspar		34.70
Soda niter	6.39		K_2O		1.27
Potash niter		2.73	Cryolite		4.28
Soda ash		5.47	ZnO		7.02
Fluorspar		5.47	CaO		1.23
Cryolite		4.28	CaF_2		5.47
Zinc oxide		7.02			
Whiting		2.22			
Total	124.31	116.54	Total	99.95	100.01

Development of New Enameling Test

The basis of the new test was that each iron should be enameled under a variety of firing treatments instead of a single one, and that irons should be distinguished from each other according to the breadth of the range of treatments within which blister-free ware was produced. Seven specimens were required to make a test and, for the particular enamels which had been supplied the Bureau, the following schedule was used. The ground coat was fired at 875°C (about 1605°F) for varying lengths of time on different specimens. The first specimen was fired for three minutes, the second five minutes, the third seven and one-half minutes, and so on by two and one-half minute increments until the seventh specimen was fired seventeen and one-half minutes. Then the cover coat was applied to all under uniform conditions, being fired for eight minutes at 800°C (about 1470°F). The enamels shown in Table I were used. Except for firing, the conditions of application as worked out in the standard process were retained. To each 3- by 6-inch casting, the ground coat (sp. gr. 1.53) was applied in a wet weight of 3.0 to 3.6 g. and the cover coat (sp. gr. 1.91) in a wet weight of 23 ± 1 g.

Different lots of castings reacted to this test in various ways. One lot might give the best results when the ground coat had been fired for five minutes and another when it was fired for seven and one-half, while a third would be almost free from blisters throughout the range of treatments. It then became apparent that no single firing treatment

could fairly be chosen as standard. For if lot *A* produced no blisters at five minutes but did produce blisters at seven and one-half minutes, while lot *B* behaved oppositely, then it would be merely a matter of chance which lot the standard treatment would indicate to be better, depending upon whether five minutes or seven and one-half minutes were chosen as the standard. A few check tests were made on lots which had been previously tested by the standard enameling procedure, and it was found that some of these which had given blisters under the standard treatment did not do so when the ground coat was fired differently. This observation may tend to explain some of the erratic results of early tests both at the Bureau and at the coöperating plants. Unfortunately, it was impossible to check over more than a very few of the previously obtained results, since the necessary specimens were not available. That part of the report preceding the use of the "range" method of testing therefore should be considered chiefly as a narrative of events rather than a presentation of data to be used for drawing conclusions.

Factory Use of Range Method of Testing

This "range" method of testing the enameling properties of irons appeared to embody a satisfactory means of differentiating between specimens having different blistering tendencies. It was considered necessary, however, to establish the reliability of the test further before proceeding with the work.

At a meeting of representatives of the Bureau and the AMERICAN CERAMIC SOCIETY, it was decided that since two lots of iron had given good and poor results respectively under this method of enameling, these results would be checked under varying conditions. Previously prepared specimens having been almost exhausted, it was necessary to prepare new ones, which were planned to be duplicates of the originals as nearly as possible.

Tests were arranged to be carried out on a relatively large scale, both at the Bureau and in the laboratories of two plants, using two types of enamel.

An electric furnace was used for melting the iron, and ten plates of 18 specimens each were cast from a single heat. Four heats of each iron were made, bringing the total for these tests to 1440 specimens.

The plan was for seven specimens from each heat to be processed with the standard enamel at the Bureau, and seven at each of the coöperating plants. Duplicate specimens were to be processed with a high lead, single coat enamel. The Bureau carried out this schedule in a small electric enameling furnace and also in a large gas-fired furnace. The high lead enamel used was of the composition shown in Table II.

The use of different enamels and enameling practices in these tests led to certain irregularities in results, just as had previously been the case with the coöperating factories, in which widely varying practices

TABLE II
SINGLE-COAT ENAMEL

Batch Weights		Melted Weights	
Raw Material	Parts	Ingredient	Parts
Canadian feldspar	19.90	Feldspar	19.90
Flint	12.20	SiO_2	12.20
Borax	21.05	Na_2O	5.43
Red lead	35.30	B_2O_3	8.97
Fluorspar	10.02	PbO	34.60
Cryolite	3.34	CaF_2	10.02
Soda niter	5.52	Cryolite	3.34
Zinc oxide	5.53	ZnO	5.53
Boric acid	2.19		
Total	115.05	Total	99.99

and types of enamels had also been used. Very little difference was shown between the two irons when the low fusion enamel was used, but the distinction was quite apparent with the standard two-coat enamel and checked previous observations, that in general more blisters were obtained with the iron designated, *L*, than with the one designated, *R*. (Table III.)

TABLE III
COMPOSITIONS OF PIG IRONS USED AS DETERMINED BY CHEMICAL ANALYSIS

Pig iron	Carbon			Mn	P	S	S
	Total	Comb.	Graph.				
R	3.61	0.65	2.96	0.68	0.78	0.045	2.66
L	3.73	0.59	3.14	0.78	0.50	0.090	2.55

Of greater significance, however, was the difference in enameling properties between various heats of the same iron. Especially heat 4 of iron *L* showed much less tendency to blister than the other three heats of this iron. This difference existed in spite of the fact that the melting was done in an electric furnace where conditions can be controlled considerably better than in a cupola. Figure 1 illustrates the difference between one of the better heats of iron *R* and one of the poorer of iron *L*. Chemical analyses and metallographic examinations have been made and these tests show differences to exist between the different heats. It is not yet entirely certain how the observed differences are connected with the variations in behavior.

Baking A study was made on the effect of "baking" the coated specimens before firing. The term "baking" is used here to refer to a heat treatment given, after the enamel has been dried on the piece, at a temperature which is not high enough to fuse the enamel, and must not be confused with the terms "firing out" or "annealing," which are applied to a treatment given the iron at a red heat before application

FIG. 1.—Numbers indicate minutes of firing ground coat at 875°C (about 1605°F). Cover coats all fired 8 minutes at 800°C (about 1470°F). Top row is iron *R* and bottom row iron *L*. These specimens were all water-soaked before enameling, but are fairly typical also of results obtained without water-soaking.

of the raw first coat. The particular baking treatment chosen for experimental purposes was heating the specimens for 8 minutes in a furnace at 500°C (about 930°F). Three baking tests were investigated; *viz.*, baking only the ground coat, baking only the cover coat, and baking both ground and cover coats. The object of such treatment is to allow the source of gas to respond to the stimulus of heat and evolve gas at a temperature which is too low to fuse the enamel, so that the gas is not entrapped. Tests made at the Bureau indicated that this treatment is beneficial. This result was checked in one plant but not in another in which it was tried.

Water Soaking Tests

One hypothesis which might account for any benefit derived from "baking" the specimens is that moisture is present in the pores of the iron, which expands to many times its original volume when transformed into vapor and raised to the temperature of an enameling furnace, thus furnishing a source of blister-producing gas. If this were true, then the castings which blistered more might be expected to contain more pore moisture, and if this moisture were removed before the enamel coating had fused enough to entrap the gas, the finished piece should not be blistered. Data were obtained on this question in the following way. A set of seven castings of iron *L* and a similar set of iron *R* were soaked in water after sandblasting, for a period of 40 hours, after which they were removed from the water, wiped with a towel, and immediately sprayed and put through the range of enameling treatments. These specimens gave the results shown in Fig. 1, which was taken from the water soaking tests, but is typical of results obtained with these two irons when no soaking treatment is used, with the exception that more blisters were obtained on the 3- and 5-minute specimens of iron *L* with the water soaking treatment.[5] The fact that iron *R* did not give blisters in spite of the water soaking treatment indicated that the major cause of blisters must be something other than moisture in the iron.

There is experimental evidence that enamels lose weight when heated to 500°C (about 930°F) after the customary drying treatment. The gas thus released may have a bearing on any tendency of the baking treatment to reduce blistering. It may possibly be a useful reagent for removal of whatever it is in the surface of the iron that is responsible for blistering. (See following section.)

Locating the Source of Blisters

It is a well-known fact that for satisfactory enameling of iron ware the surface of the ware must be properly cleaned, but it seems doubtful whether

[5] The ends of the castings opposite the identification holes as shown in Fig. 2 typify results obtained without water soaking.

the full significance of the cleaning operation has been generally recognized.

In some of the tests it was noticed that an abnormally extended sandblasting resulted in a noticeable improvement, although the normally cleaned specimens showed no indication of improper sandblasting and appeared satisfactory for enameling. Experiments were subsequently made in which the surface of each casting was machined off across one end, the other end receiving only the regular sandblasting. Specimens prepared in this way were put through the range of firing treatments which has been described, with results as shown in Fig. 2. Here again, specimens from one of the better heats of iron *R* and from one of the poorer heats of iron *L* were used. The unmachined ends of both sets of specimens showed the same result as in Fig. 1, namely, that iron *R* gave very few blisters under any of the treatments, while iron *L* blistered throughout the greater part of the range. On the other hand, the machined ends of both sets of castings were relatively free from blisters throughout the range of treatments. In removing the original surface of iron *L* the source of blisters had been removed.

These experiments with the machined castings may be considered as marking a turning point in the investigation. The possibility that the source of blisters might be concentrated at the surface had been considered at an early stage of the work, but no definite proof of it was obtained at that time. The reason for this lack of evidence can be seen by reference to Fig. 2. Very little difference between the machined and unmachined ends of the specimens is apparent at the shorter firing periods. It was only when the enameling test was broadened to include abnormally extended firing periods that the decided effect of removal of the surface became obvious. This effect having once been established, the plan of study was modified. Whereas previously study had been directed primarily at the chemical composition, physical soundness, and microstructure of the iron as a whole, the work now became concentrated on the search for differences between the surface and interior layers of blistering castings, and between the surface layers of blistering and nonblistering castings.

The machining process caused a change in the character of the surface enameled and the question arose as to how much the added smoothness might have contributed to the improvement. In order to throw light on this question, and also to investigate a possible remedy, several tests were made in which the surface of one end of each specimen was removed by a severe pickling. This, of course, tended to open up the pores existing at the surface of each specimen and render it even rougher than the untreated end. No full study of pickling as a remedy for blisters has yet been made, but enough results have been obtained to

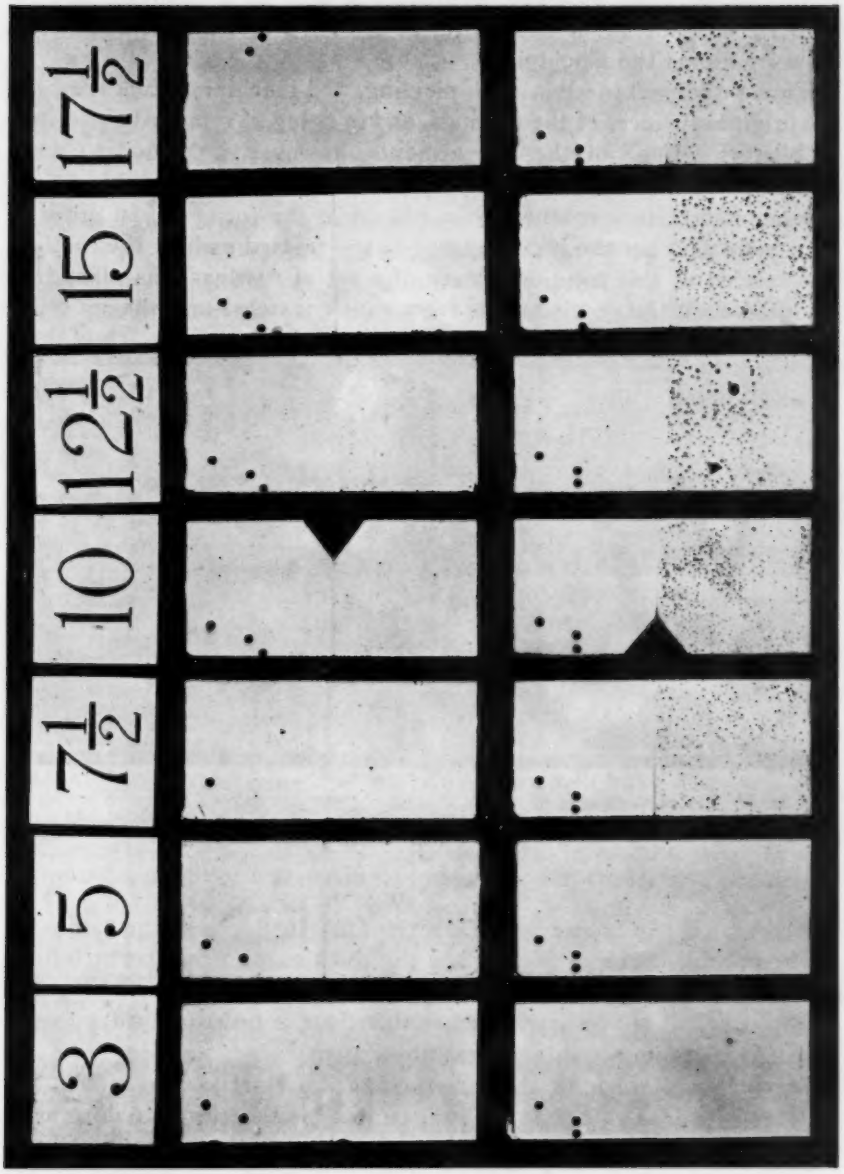

FIG. 2.—Surfaces of ends of plates bearing identification holes are machined off before enameling. Top row, iron *R* and bottom row, iron *L*. Numbers indicate minutes of firing ground coat at 875°C (about 1605°F). Cover coats all fired 8 minutes at 800°C (about 1470°F).

show that pickling with 12% hydrochloric acid for 10 minutes at 60°C (140°F) was almost, if not quite, as effective in eliminating blisters from iron *L* as the machining.

Thus prolonged sandblasting, pickling, and machining each removed the original surfaces of the castings, and in doing so removed the source of blisters. Each of these treatments, however, lightened to some extent the treated portion of each casting, and made it subject to a quicker rise in temperature when placed in the furnace. In order to determine whether the improvement of the treated ends of the castings was related to this condition, each of a set of castings was planed off at one end on the opposite side from that enameled and the set given

FIG. 3.—Plates machined off at slight angle before enameling. Lettered plates are graphical representations of appearance of plates after machining. Unshaded portions were machined; shaded portions had normal sandblasted surfaces. Ground coat fired 10 minutes at 875°C (about 1605°F) and cover coat 8 minutes at 800°C (about 1470°F).

the regular range of enameling treatments. In this case the thin ends of the castings were no better than the thick ends, a result which indicates that the improvement which accompanied the above-mentioned treatments can not be attributed to the effect of decreased thickness of the castings upon the rate of heat absorption.

Having confirmed by these tests that the chief source of blisters, at least with iron *L*, lay at the surface, the next step was to determine to what depth it was necessary to go to eliminate this source. For this purpose a number of specimens of iron *L* were sandblasted in the normal fashion (which is insufficient to prevent blistering on this particular lot) and machined off at a slight angle to the surface so that a part of the original surface area was left untouched. The depth of the cut varied from an infinitesimal amount, at the boundary between

the machined and normal surfaces, to a maximum of several thousandths of an inch. Since the original surfaces were not perfectly flat, the boundary between the machined and normal surfaces was irregular in shape. The results obtained are typified by the two specimens shown in Fig. 3. The shaded pieces represent graphically the condition of the specimens before enameling. The shaded areas represent the normal portion of each surface, and the unshaded areas represent the machined surfaces. An extremely shallow cut was apparently quite as effective in eliminating blisters as one several thousandths of an inch deep, for blistering disappeared entirely at the boundary of the machined surface. The matter which gave rise to these blisters thus appears to be concentrated in an extremely thin layer at the surface of the iron.

Distinction between "Good" and "Poor" Irons

It is not believed that matter held at the surface of a casting is the only source of blisters. The results shown in Figs. 1 and 2 prove the marked effect of variations in firing conditions. The soundness of the castings also undoubtedly affects blistering tendencies. From the data at hand it appears, however, that insofar as one prolific source of blisters is concerned, the distinction between a "good" and "poor" cast iron lies either (*a*) in the greater tendency of the "poor" iron to form or accumulate blister-producing ingredients at the surface, or (*b*), if such matter is uniformly present in all cases, in the greater difficulty of removing it from the surface of the "poor" iron. Several tests were made to determine whether the "good" or the "poor" iron is more easily cleaned. This was done with the aid of an apparatus so constructed that it would deliver a known weight of standard sand at a constant pressure. In these preliminary tests 1000 g. of sand were used at a pressure of 60 pounds per square inch. Two specimens of of iron *L* lost 0.6 g. and 1.0 g. respectively, and two of iron *R* lost 1.2 and 2.0 g. respectively.

Check tests confirmed the observation that, of these two sets of castings, the nonblistering loses weight more rapidly under a given sandblast treatment. At first glance it might seem that these results tend to favor assumption (*b*) that the deleterious material is present in both sets of specimens, being more readily removed from the nonblistering set. But the fact that a nonblistering casting loses weight more readily is in itself no proof that it contains any of the blister-producing material at its surface. On the other hand the very presence of the blister-producing material may be responsible for the greater resistance of the "poor" casting to loss of weight by sandblasting. Also, there is some evidence at hand which tends to indicate the probable correctness of assumption (*a*) namely, that only the blistering castings form or accumulate such material at the surface. This evidence com-

prises the meager tendency exhibited by the "good" castings to produce blisters even when obviously poorly sand blasted.

Conclusions

Inasmuch as the investigation is now incomplete, it is not desirable to draw extensive conclusions. Nevertheless several facts have been established which serve as a foundation upon which to base additional work. These may be stated as follows:

(1) Variations in enameling practice have a considerable influence upon the tendency of any given casting to cause blisters in the enamel

(2) There is a definite difference in the tendency of different castings to produce blisters when enameled under identical conditions.

(3) Different heats of the same pig iron may have different blistering tendencies, even when melted in the same electric furnace.

(4) The development of an enameling test which includes a variety of firing conditions was necessary to bring out clearly these differences in the tendency of different sets of castings to produce blisters.

(5) A baking treatment of the enamel-coated castings at 500°C (about 930°F), before firing, in a majority of cases appreciably reduced blistering tendencies.

(6) Although such factors as the soundness of castings and the firing treatment must have a considerable influence on blistering, yet the data indicate that the most prolific source of blisters from iron used in this investigation is confined to a very thin surface layer. The removal of this layer by mechanical or a suitable chemical means causes a tremendous improvement.

Acknowledgments

While this investigation was first undertaken by the Enameled Metals Section of the Bureau in 1922, in coöperation with the Research Committee of the Enamel Division, AMERICAN CERAMIC SOCIETY, under its chairman at that time, R. R. Danielson, the present enlarged coöperative plan of work which this report covers was instituted in 1924 jointly by the Ceramics, Metallurgy, and Chemistry Divisions of the Bureau and the Enamel Division Research Committee, under the chairmanship of H. F. Staley, with some thirty-six enameling and other interested companies coöperating through the Committee. For the past year R. R. Danielson has again served as chairman of the Enamel Division Research Committee, to the many members of which acknowledgment is made for their assistance in planning and furthering the work.

H. G. Wolfram was in charge of the Bureau Enamel Section's participation during about two years of the investigative work under the coöperative plan. G. T. Thaler has rendered valuable assistance in the enamel laboratory, and L. D. Jones in the foundry section has done creditable work in the preparation of specimens.

PHOTOMICROGRAPHY IN NATURAL COLOR[1]

By Thomas S. Curtis[2]

ABSTRACT

An outline of the processes and technique used in the Vitrefrax Laboratory for the preparation of permanent and faithful records of ceramic and refractory body structures.

Introduction

To nearly every worker who has had the privilege of viewing mineral fragments or thin sections through the petrographic microscope under polarized light, must have come the urge to record the beautiful color formations in permanent prints that may be preserved for all time, to be taken from the file as required, and to be shown in all their glory as well as for their practical educational value in years to come.

The delineation of delicate and complex structures is difficult at best, and while the contrast filters and panchromatic plates so highly developed in their present degree of perfection greatly facilitate the work of the photomicrographer, it is not possible to bring about the reproduction of a section of delicate and feeble contrasts in monochrome without losing at least a great part of what the original observer saw through the eyepiece.

Realizing the desirability of making such valuable and useful records, both for scientific, and for advertising and selling purposes, it was felt that the subject was deserving of considerable study and work in the development of a technique that would at once be faithful and permanent in its reproductions, and sufficiently simple and dependable to bring it within the realm of commercial adaptability from the standpoint of cost.

The literature of the subject abounds with processes and methods that may be used, and all of them are workable. Upon trial, however, it was found that nearly all, when used as instructed, gave rise to some trouble or lack of dependability. Either the results were not permanent, or they were impossible of duplication. The net result of study has been, not the discovery of a new process, for it is certain that in Wall[3] will be found a description of every known process as well as of any that may subsequently be "discovered" but rather we have developed a technique or systematic method of natural color photography which was borrowed a bit here and there and has combined the best points of each into a workable whole that has been reduced to a mechanical basis, and which notwithstanding, produces results both beautiful and faithful, as well

[1] This paper was preprinted and presented before the Ceramic Society of Paris, May 29, 1928. Received May 5, 1928.

[2] Director of Research, Vitrefrax Corporation, Los Angeles, California.

[3] E. J. Wall, The History of Three Color Photography, American Photographic Publishing Company, Boston, 1925.

as permanent. The technique is equally well adapted to micrography or to the photography of gross objects.

No endeavor will be made in this paper to cover the fundamentals of photomicrography, since these basic features are splendidly outlined in a little booklet published by Eastman Kodak Company[4] and available at nearly every one of their many retail stores. Neither shall we go into the underlying principles of color photography as such, because of the thoroughness with which Wall has again covered his subject from the practical standpoint.[5] We shall, on the other hand, at once proceed to describe the three methods that are utilized in our laboratory, giving only such basic principles as seem necessary to the manipulation of the processes.

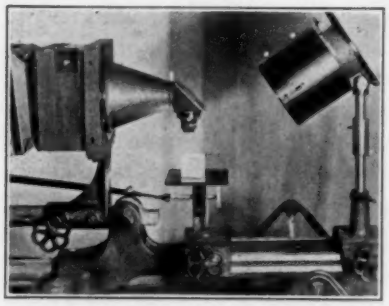

FIG. 1.—The camera arranged for macroscopic pictures of ground surfaces, under oblique illumination. The Micro Tessar objectives are so well corrected that small filters may be slipped over the tiny lens in succession for color separation work if desired. Remarkably informative studies of the occurrence and formation of iron specks, etc., may thus be preserved in actual color. This is especially useful in studying the effects of reducing and oxidizing atmospheres on the development of color blemishes in whiteware bodies.

For the production of transparencies in natural color, we are blessed with a process so simple and so faithful that it is actually easier and quicker to work than is the making of an ordinary black and white lantern slide. The screen plate, so-called, by reason of the fact that its color elements are arranged as a myriad of almost microscopic dots of the three primary colors, red, green, and blue-violet, offers the cheapest, quickest, and most all-around satisfactory means of natural color reproduction. Several makes are on the market, the best known being the Lumiere Autochrome, the Agfa Color Plate, the Paget Color Plate, and a recently introduced and very promising color film pack called the Lignose Color Film Pack. There is little choice between them insofar as quality is concerned, and whatever brand is available in the local market will doubtless prove acceptable to the worker.

Technique of Screen Plate

The technique of the screen plate is very simple. The plate is placed in the plate holder in total darkness, which is easy after one

[4] Photomicrography, Eastman Kodak Co., Rochester, N. Y.

[5] E. J. Wall, Practical Color Photography, American Photographic Publishing Co., Boston.

becomes accustomed to the feeling of the contents of the package. Unlike ordinary plates, the screen plate is placed in the holder with the glass side out or facing the lens. A sheet of cardboard packed with the plate is retained in contact with the latter to protect the very delicate emulsion from injury by springs in the plate holder.

Exposure is made through a special color filter which must be correct for the particular light in use, a K_1 Wratten Filter serving admirably for Mazda light, a K_2 being fairly correct for arc light, while for daylight, the special compensating filter supplied by the makers of the plate must be used. It may be mentioned that the filters stated are suitable for the Autochrome plate but not for any of the others listed above.

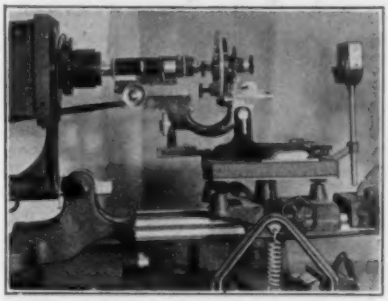

FIG. 2.—A close-up of the petrographic instrument on the camera stand. At the extreme right may be seen the water-cooler cell, in front of which is placed the color analysis filter in natural color photomicrography. The massive construction of the mount is essential for critical work on thin sections at high magnifications. The apparatus used for monochrome and polychrome photography of thin sections by ordinary or plane polarized light. The outfit is a standard Bausch & Lomb Petrographic LCH Microscope mounted on the large camera stand. Shock absorbers effectually prevent vibrations from reaching the optical system, thereby making it possible to complete three or more successive exposures of the same field without the slightest difficulty from lack of register or destruction of definition due to vibration.

Exposure is about 60 times the normal Extra Rapid Plate exposure for daylight, and Mazda light, but somewhat less than this for arc light in the microscope. There is no way known to us to determine the correct exposure in the microscope except by trial, which means wasting one plate, but once the correct exposure has been obtained for a given section and at a given magnification, it may be noted on the label of the slide for future reference. Practically every other field of that slide will require the same exposure at the same magnification providing the adjustment of the light is such as to bring out the best definition in the specimen each time.

Useful hints on exposure are given in the Eastman Book.[4]

The development of the screen plate is simple, if the operations are standardized. Temperature of developer should always be the same, preferably 65°F and if exposure has been approximately correct, the plate is developed fully in two and one-half minutes using the Metoquinone developer recommended by the makers of the Autochrome plate. Development should be entirely in the darkness, with no

light in the room save that of a dim green Wratten Series 3 safelight which should shine on the time clock and never into the tray. When the time has elapsed the plate is briefly rinsed in clean water at the same temperature as the developer and, still in total darkness, transferred to a tray of the reversing solution, formula for which is published in the literature with the plates.[6]

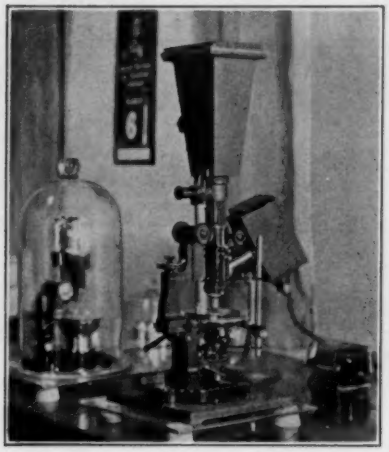

FIG. 3.—A close-up of the bench apparatus, showing B. & L. research model petrographic instrument fitted with record camera which may be swung aside or back again in an instant. A prism eyepiece in the camera enables one to work comfortably in visual observations without disturbing the camera in the event that many quick record pictures are to be exposed.

The plate is left in the reversing bath, still in total darkness for two minutes, after which the white light may be turned up and the plate examined by transmitted light. If exposure has been correct, the picture is clear, transparent, and brilliant in its full colors. If it is dull and foggy, it was underexposed; if it is transparent and thin and almost devoid of color, the exposure was too great.

The plate, after coming from the reversing solution, should be washed for a minute in clean water at the same temperature, then placed back in the original developer in daylight or strong artificial light for three or four minutes to thoroughly blacken the undeveloped silver. After the second development is complete, the plate may be washed for just a few minutes and then placed in a gentle breeze free from dust to dry. It is now finished and ready to be varnished, bound up with a cover glass and filed for future reference.

To summarize technique for Autochromes, which varies a bit in some particulars from published instructions, we may say: Develop in total darkness, by time and temperature only, and not by visual examination of the plate, which nearly always dulls the result by fog; keep all solutions and wash water at 65°F to avoid frilling of the emulsion; complete reversal of the primary image in total darkness

[6] In this connection, let us caution the worker against the permanganate reducer that is sometimes recommended. Our experience with it has been so discouraging as to cause us to discard it in favor of the bichromate of potash reverser. Reversing solution should also be at the same temperature as the developer and rinse water.

instead of turning up the light at once as recommended; do not wash for more than two or three minutes after final development to avoid green spots and blemishes.

Direct Color Separation Negatives

Unfortunately, the screen plate is difficult to reproduce without the loss of much of its beauty of color and gradation and, while a method has been worked out by means of which we are able to produce very acceptable color prints on paper from our valuable screen plates that cannot well be duplicated, we much prefer to employ direct color separation negatives made in the camera of the microscope which process is described here.

In many cases a transparency, which must be viewed by transmitted light is not satisfactory. It is difficult to exhibit except when projected from a lantern, and still more difficult to send through the mail on account of its weight and the liability of breakage. A color print, on paper or celluloid, however, may be exhibited anywhere, at any time, and it is thus far more satisfying and useful. At the outset, we must caution the ambitious worker that it is far more difficult to produce than the transparency, although the color prints may be duplicated by the score or by the hundreds if desired, while through the medium of the three- or four-color process printing method, reproductions for literature may be made by the thousand. The illustrations in a companion paper were reproduced directly from color prints by the engraver for the *Journal*, which is graphic evidence of the possibility of faithful color reproduction in large quantities.

The principle of color separation on three negatives is exceedingly simple. Three light filters are employed, red, green, and blue-violet, transmitting only their respective colors. These filters are included in the Wratten set of eight contrast filters and numbered A-25 for the red, B-58 for the Green, and C-49 for the blue.

It will be seen that if three negatives are made, one through each of these filters respectively, taking care not to touch the stage of the microscope or to vary the position of the picture on the ground glass between exposures, there will be obtained a record of all the red, green, and blue of the subject on the respective negatives. Since from these three colors of light, if they be superimposed upon a screen in the proper percentages, we may obtain every color value in the spectrum, it will be seen that our three negatives contain the color records of all the colors in the original in the proper analytical values, and with every light and shadow properly delineated, providing the exposures have been correct.

Making the Negatives In the first place, panchromatic plates only may be used since we must have sensitivity

to all colors. The author has used both the Wratten commercial and M-plates with entire success and finds them very uniform. Unfortunately, the cards which are included in every box of the commercial plates and which aid greatly in determining exposures by having printed upon them the relative exposures for the three filters for daylight, are devoid of any such suggestion in the case of the M-plates which are especially fine for micrography by reason of their wide range of contrast and very fine grain. Therefore we must needs cut and try again, but this time we have much more latitude.

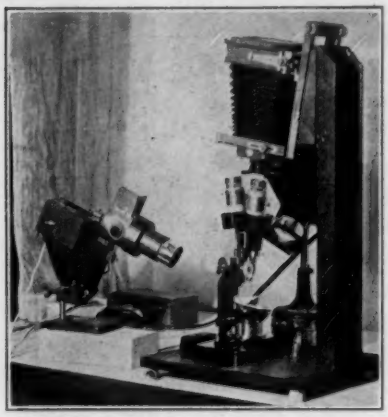

FIG. 4.—The deep field apparatus for the study of very rough natural fractures. The Leitz Stereo-binocular microscope gives a great depth of focus and vision in the third dimension. If record pictures are required, they may be made either in natural color or in monochrome by means of the small view camera, which may quickly be swung out of the way.

The object is to have all three negatives as nearly alike as possible when photographing a subject of neutral gray values through the three analysis filters. To do this, a slide should be selected which is clear and transparent, with no discernible tint to the balsam with which it is cemented. No mineral section should be chosen which in itself has a visual color except when viewed by polarized light.

The slide is adjusted to give a clean black and white or gray and white image on the ground glass, with the polarizer thrown out, and the light adjusted to reduce the prismatic color fringe to a minimum at the boundaries of the crystal if achromatic lenses are used.[7]

When loading the plate holders the number corresponding to that on the plate holder should be written across the back of the plate with a wax negative pencil which readily writes on glass and may be wiped off after the development is completed. The purpose of the numbers is to identify the respective filter negatives after finishing.[8]

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[7] Highly color-corrected apochromats are so desirable as to be almost essential to successful color work. They cost more, but they save endless time and falsification of results due to phantom fringes of colors and to the occasional tendency of the not fully corrected achromatic objectives to produce different sized images of the three-color negatives.

[8] To save endless disappointment form a habit of doing every detail of the work and never deviate from that routine. When loading plate holders, place No. 1 uppermost in

Place the No. 1 holder in the camera with the *A* filter in position in front of the water-cooling cell, and never fail to see that water is in the cell or you may ruin a filter by melting the balsam with which it is cemented. Be sure the shutter is closed, then draw the slide, permitting the camera to come to rest on its shock absorbing springs before making the exposure. If the image on the ground glass is sufficiently illuminated to focus easily and without eyestrain even through the red filter, the correct exposure is likely to be something of the order of 20 seconds for the *A* or red filter negative, 25 seconds for the *B* or green, and 35 seconds for the *C* or blue-violet filter plate.[9]

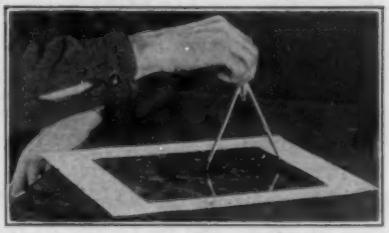

FIG. 5.—Placing register crosses on negative by bisecting the vertical cross-hair with bowpen compass and India ink, taking the intersection of vertical and horizontal cross-hairs as the radial point.

In order to check the exposure the worker is advised to proceed as follows: Assuming the optical set-up to be as above specified, open the shutter with plate fully exposed in the camera, *i.e.*, with the slide drawn. By means of a seconds timer, count five seconds, then close the shutter. Carefully insert dark slide a distance of approximately one-fourth the distance so that the plate is covered by a quarter of its area, then open the shutter again for five seconds. Close shutter, and push the slide in so that one-half the plate is covered, then again open shutter, this time for ten seconds. Repeat the operation of pushing in slide to three-quarters of the distance and expose for twenty seconds. Close plate holder and make note of the fact that the relative exposures were respectively 5, 10, 20, and 40 seconds.

Expose the No. 2 plate in exactly the same way through the *B* or green filter. Finally repeat with the *C* or blue-violet filter. The test record will now be complete, and will not have to be repeated unless work of the utmost delicacy of color rendering is to be done, when it will be necessary to test each box of plates, since there is a slight variation of the emulsion from lot to lot. For all work except the most critical, however, it will take an expert to detect deficiencies in the rendering

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the pile, so that you may write 1 on the back of the plate as it goes in the holder. Turn it over and you have No. 2, etc., until all are loaded and numbered. As you make the exposures, think of the *A* filter as No. 1, the *B* as No. 2 and the *C* as No. 3, then on proceeding to the next batch, think of *A* as 4, *B* as 5, and *C* as 6, etc. By forming this habit you will never become confused as to which filter was used to make a given plate.

[9] The author has found this to be the rule using Wratten M-plates, electric arc of 5 amperes, apochromatic objective of 16 mm. and compensating eyepiece of 12.5 ×, with camera drawn out to give 375 × magnification at this optical combination.

from lot to lot, if once the relative exposures have been carefully determined in this way. Needless to say that if the worker should change to the commercial Panchromatic plates, for any reason, it will be necessary to make the test over again as the filter ratios are not the same for the two varieties of plates.

Development of the Panchromatic Negative

The development of the plate is perhaps, next to correct relative exposures, the most critical of all the operations, but, withal, the easiest to control. The color balance in a trichrome rendering is something of the utmost delicacy and as the worker becomes proficient, he will be amazed at the wide variation which the slightest modification of one of the three printing colors can make in the final result.

The technique is based upon the use of Pinakryptol Grün, a German dye,[10] as a desensitizing agent, and the new Eastman borax developer, known as D-76, and developed especially for the motion picture industry. This combination offers at once the maximum of speed, convenience, and certainty of results.[11]

The developing technique is as follows: In total darkness, unload Nos. 1, 2, and 3 plates from their holders and place on a clean, felt-covered shelf with the edges of the plates protruding to facilitate picking up in the darkness. Have the Pinakryptol solution poured into a tray immediately under the shelf carrying the plates. Have the Wratten Series 3 green safelight shining on the seconds timer but not into any of the trays or on the plates. Have the developer poured into three trays immediately adjacent to those containing the desensitizer, but

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[10] Regardless of all instructions that have been published, the author favors the use of a desensitizer in development. The results are more certain, there is absolute freedom from the fog that is so troublesome when working with panchromatic materials, and one can do an increased amount of work with a useful light in the darkroom.

[11] To make the desensitizer, dissolve $^1/_2$ gram of Pinakryptol Grün in 2500 cc. of distilled water. Solution is facilitated if the dye be placed in a beaker with a few ounces of water and brought to just under the boiling point. Stirring with a glass rod will hasten solution. When no undissolved particles can be seen in the dark green fluid by strong transmitted light, pour the concentrated dye solution into the remainder of the cold water and store in a glass-stoppered brown glass bottle. The solution can be used over and over again.

Through the courtesy of Ray Claflin, manager of the Broadway Eastman Kodak Stores, Inc., of Los Angeles, we publish the formula for the D-76 motion picture developer, which has been found one of the most useful and remarkable of all those tested. The solution keeps perfectly for months at a time and it renders a beautifully delicate graduation of tones with exceedingly fine grain. Practically any desired degree of contrast may be obtained without fog on the one hand or harshness on the other. Finally, with the Pinakryptol desensitizer, there is absolutely no more difficulty or annoyance in developing panchromatic emulsions that there is in handling a slow lantern slide plate.

provide some distinguishing feature between the developer trays and the desensitizer tray.[12]

Next to the developer trays have a large, deep tray of clean water, then either a tank large enough to take all three or more plates for the acid fixing bath, or else three more trays of the latter. Above the developing trays provide a drop light in a tin reflector with a 10-watt ruby bulb and a convenient push switch on the socket.

Proceed with the development by putting on a pair of the highest quality rubber gloves, to protect the fingers from the green dye (high grade ones will serve for a year while cheap ones wear out in the first week) noting the seconds hand of the timer; when it comes to 60 immediately lower the No. 1 plate into the desensitizer. Leave it there for just one minute, and in the meantime pick up the No. 2 plate. As soon as No. 1 has had one minute of the desensitizer, lift it out and lower No. 2 into the bath, immediately placing No. 1 into the developer, and setting a minutes-timer to 60. Rock all trays every spare moment. When No. 2 plate has been in the desensitizer one minute transfer it to the second developer tray and drop No. 3 into the desensitizer. Follow by placing No. 3 in its developer tray when the minute has elapsed. It will be seen that each plate went consecutively into its developer exactly a minute apart. By the time No. 3 has been in the developer a minute, cover the trays containing 2 and 3, and turn up the ruby light for an examination of No. 1 which will have had three minutes' development. The image should just be appearing on the

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The D-76 developer is made as follows:

Elon	4	grams
Sodium sulphite	200	"
Hydrochinon	10	"
Borax	4	"
Water	2	liters

Careful observance of the following mixing directions is essential in order to effect complete solution: Dissolve the Elon in a small quantity of water at 125°F. Dissolve separately in a small quantity of water at 160°F about one-quarter of the sodium sulphite, adding to this second solution, the Hydrochinon, stirring until dissolved. Add this second solution to the Elon solution. Now dissolve the rest of the sulphite in hot water at 160°F, add the borax, and when completely dissolved add this last solution to the first and bring up to two liters with cold distilled water.

The developer should be used at exactly 65°F which is easy of accomplishment either by means of ice or external heat as the case may be. After being used, it can be put back in the bottle with the fresh stock; in fact, a two-liter stock of the solution has been used for two months. If anything, the quality of the negatives is improving. Exhaustion is denoted by a slowing up of the action, but it required a half gross of 8 by 10 negatives developed over a period of several months to bring about the first signs of diminished activity, in the case of the first lot prepared.

[12] The author uses a ridge of wood somewhat higher than the trays so that it can be felt in the dark.

face at this time. If the entire plate is blackened within three minutes, exposure has been hopelessly too great, while if there is no image whatsoever, the exposure was much too short.

Cover the No. 1 tray, a piece of lacquered cardboard being handy for this purpose, and proceed to get ready for other work, since there will be a couple of minutes before another examination is needed. If you are to follow with additional exposures, this time may be used to reload plateholders, of course, taking the precaution to turn off the ruby light while so doing. Rock all trays occasionally to avoid streaks in development.

FIG. 6.—Transferring register marks from negative to carbon tissue before printing. After one set is placed, the opposite side of frame back is opened to transfer the other cross.

At the end of the first five minutes, turn up the ruby light and examine the No. 1 plate again. By this time the image will have developed fully and richly on the emulsion surface. It is herein that the need for experience comes. For color separation work, the negative must needs be delicate and soft, with richly modulated tones. The best analogy is that of a beautiful portrait negative, having no clear glass and no dense or opaque highlights. Harshness is fatal, so that if one is unfortunate enough to develop harsh negatives, he might as well do the job over again and save himself the greater labor of trying to make a color print from them.

The guide to sufficient development is to have enough red light to be able to see clearly the details in the shows which, of course are the lightest parts of the negative. If shadow detail does not come within eight minutes, the negative is so underexposed that it had better be made over again.

If the series of exposures has been within the range of correctness that will give a good exposure on one of the scales of the No. 1 plate and that at five minutes, the shadow detail is delicately but clearly defined on the face of the plate, quickly lift the plate from the solution and glance at the back. If there is a faint but distinct trace of the blackest part of the image to be seen on the back, the negative is developed and should be quickly rinsed in the clear water and placed in the fixing bath solution, careful note being made of the total time of development the moment the plate is removed from the developer. Regardless of how they look, or what the judgment is in regard to the No. 2 and No. 3 plates, they must be removed from their developer, rinsed, and placed in the fixing bath at exactly one and two minutes, respectively,

after the No. 1 plate was removed. Whatever deficiencies occur in the No. 1 plate, which is the blue printer of the trio, must be present also in the other two.

If upon first examination of the back of the No. 1 plate, there is no visible sign of the highlight image, place it back in the developer for 30 seconds and then examine again; if still no signs, give it another half-minute. This may be repeated up to eight minutes but if the development goes further than that, be prepared for a harsh, contrasting result that will not make a faithful color print.[13]

FIG. 7.—Transferring register marks to final opaque celluloid support through holes punched in carbon tissue after squeegeeing the yellow print to the celluloid. Register marks on red and blue prints are subsequently brought to match, as each is successively applied.

When all negatives are developed and fixed, that is when all of the milky white undeveloped silver residue has disappeared from the back, remove the plates from the hypo and place in a large, perfectly white tray of clear water, then turn up the white light.

With the three negatives side by side, make note of which stripe or band on the No. 2 and No. 3 negatives corresponds in tone values to the correctly exposed stripe on No. 1. That ratio is the cue for subsequent exposures in color separation, in order that all values may be correctly rendered. While the exposure itself will vary according to the magnification and the brilliancy of illumination, the ratio of relative exposures for the three filters will remain the same. This ratio should be written down on a card and kept on the stand of the apparatus for instant reference.

The washing of the negatives should be conducted in running water for at least fifteen minutes and preferably thirty, after which they may be very carefully swabbed off, under water, with a tuft of soft cotton, then racked up to dry preferably in a gentle breeze from a fan.

The procedure for the color separation negatives is exactly as described for the test negatives.

[13] We have tried to convey the idea that sufficient exposure must be given to afford complete but soft development in from five to six minutes with eight at the limit. It must be realized, however, that on the test plate, at least a portion will be much under-exposed and a portion very much over-exposed. Therefore, in judging development of this plate, the worker must choose that stripe which on the face of the plate shows good modelling and gradation of highlight, half tone, and shadow detail at the end of five minutes, and upon turning to the back, to look for the indication of density in the highlight blackening of that particular stripe only, ignoring what the others may look like both on the face and the back.

Selection of the Field under Polarized Light

Since the object of making a photomicrograph is to bring out clearly the structure of the field, we are justified in making use of every device at the disposal of the petrographer to enhance the beauty or the clarity of the subject. Perhaps the most useful of these accessories is the red plate (1), which, when slipped into the barrel of the microscope, brings out details under crossed nicols that are barely discernible without the plate. Rotation of the stage should be effected until the desired details are clear and well defined against the background. If some purely petrographic characteristic is desired, then the position of the stage and the choice of the presence or absence of the selenite plate must rest with the petrographer who directs the illumination of the subject.

In general, it will be helpful to remember that the exposure required to avoid harshness when working with crossed nicols will be from two to three times as great as is required for the same field viewed through parallel nicols. The difference in illumination is so apparent to the eye on the ground glass, that this caution is perhaps superfluous, but in the author's experience, it has been overlooked by every worker he has advised this far. The great point to bear in mind is that the detail in the darkest portion of the field is what we must expose for, the high-light over-exposure being retarded by the relatively short development.

Another point to consider is that if the field exhibits but two colors, or better still but one color and black or gray, there is absolutely no reason for going to the trouble and expense of making three negatives. Reference to the Eastman book[4] will show which filters to use for holding back any given color and passing the second. For instance, the author had occasion to make a record of a very delicately colored section in which it was desired to show what happened to a mere trace of cobalt in a completely crystallized body. By careful manipulation of the lighting to get a clean cut illumination and maximum resolving power at 1250 diameters and with analyzer out, it was found possible to bring out delicate blue coloration of the glassy cement surrounding the crystals, which appeared in themselves a clean cut gray. An exposure through the *C* filter gave a record of the delicate blue borders, while an exposure on a second plate through the *G*-15 filter (deep yellow) completely stopped the blue and recorded the scale of grays beautifully. The resultant print was made in black and tricolor blue, the *C* negative making the black impression, while the *G* negative made the blue impression. The result was exquisite, and the record was something that no living chemist could have determined or shown, since it definitely placed the location, function, and very closely indi-

cated the percentage, of a trace of an element in an otherwise pure crystalline compound.

One last but highly essential precaution in making the constituent negatives is that the cross-hairs in the eyepiece are sharply focused on the ground glass, since it is by the delicate cross-hairs that we are to secure accurate registration of the impression on the color print. To focus the cross-hairs, grasp the barrel of the eyepiece with one hand and carefully but firmly turn the knurled head of the eyepiece, withdrawing it or pushing it in until sharp focus is obtained. This focus is quite independent of the focus of the object on the stage, and once perfected, never again need be touched unless the bellows draw of the camera is varied greatly.

Finally, it is recommended that all color negatives be made directly upon 8 by 10 plates. If the color print is worth going to so much trouble to make, it is certainly worth the small added cost of being made large enough to exhibit well on the wall in a frame or in the album before a group of several people. Furthermore, a small print is extremely difficult to register and inaccuracies of register are very offensive in it, whereas in a print of larger size, the observer may view the ensemble from a distance of normal reading vision at which distance a slight lack of register is not observable except to the critical expert, who, the chances are, could not do a better job himself.

Making the Color Print

Our choices of the subtractive methods[14] have concentrated upon the trichrome carbon process as exploited by the Autotype Co. of London and the bromoil transfer process which is used and recognized as one of the most beautiful of all media for the rendering of pictorial photographs. The few little changes we have made in the two processes have been with a view to making them less laborious and more certain in action.[15]

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[14] We have standardized on two subtractive methods of color reproduction, largely because we have found them cheap, permanent, and faithful. If our readers wish to try the other methods, many of which are fully and ably described by Wall,[5] it may be that they will have better success than we have had. This paper is not intended as an authority on the subject. It has merely been our desire to pass on the experiences that have made the art of color photomicrography not only a valuable asset to our record system but which have caused the hard work to become a pleasure rather than a chore. If we seem to take issue with the recognized authorities, it has not been with a view to inviting discussion, for which we have no taste or time.

[15] The choice between the two must depend upon the purpose for which the pictures are to be used. Given a set of "perfect" separation negatives, one may produce with the carbon tissue, a rendering that is as delicately faithful in color to the original as a perfect

Trichrome Carbon Technique

The carbon process is dependent upon the property of bichromated gelatins of becoming insoluble in hot water, after exposure to light. The degree of insolubility depends upon the intensity of the exposure.

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print from a panchromatic plate may give in its scale of grays as compared with the original. Therefore for absolute fidelity and maximum detail, the carbon process is supreme. On the other hand, nine out of ten observers will choose the bromoil rendering as their preference for sheer beauty, if shown two pictures of the same subject side by side. There is charm and softness to the polychrome bromoil properly executed that cannot be obtained with a gelatin-imbedded image. Hence, we give both methods and state our preference as follows: If it is desired to make one print only, as quickly as possible, and then to file away the negatives for future use, we use the carbon process, since with the technique we use, it is easily possible to make the three prints, develop successively in register, and have the final result hung up to dry well within half an hour without hurrying anything.

On the other hand, if we wish to make five or ten duplicates suitable for framing or passing on to customers who are likely to handle them considerably, and to whom we want to convey rather an artistic impression of the structure instead of a wire-sharp photographic record, we find the bromoil process to be superior since ten bromoil impressions can be made in an hour with conditions favorable. The only drawback to the bromoil is that it is necessary for each color impression to dry for at least three or four hours before the next is made. We, therefore, usually make the yellow impression in the morning, the red in the afternoon and the blue the next day.

In point of cost, the bromoil is far cheaper in materials but perhaps somewhat more time consuming. Neither one is expensive, the total cost of material for an 8 by 10 carbon print on celluloid being under one dollar. An artist's painting, which could not be more beautiful and certainly not as faithful, would cost at least one hundred dollars if done by a man capable of handling the subject.

Statement of a few of the underlying principles of subtractive color printing will assist in avoiding common pitfalls. The complete three-color record is made up of three separate impressions of exactly the correct values of rose-pink, blue, and yellow ink or pigment. The negative taken through the *A* or red filter makes the blue print. That taken through the *B* or green filter makes the rose-pink print, while that from the *C* or blue-violet filter makes the yellow print. In short, the printing colors are the complementaries of the taking colors.

Successful rendering of the color original, depends first, upon the correct values of each of the printing colors, and second, upon the delicacy of modelling of the respective prints. If the print is harsh and "contrasty," so much color will be carried by the dense, black shadows as to destroy all semblance of detail in them when three successive impressions have been made in the three colors. On the other hand, deep and beautifully modelled shadows, full of detail are readily obtainable if the negatives have been sufficiently fully exposed and developed to a soft brilliancy. Hence the detail with which we went into the phase of exposure and development.

Therefore, we sum up, the three successive color prints, when viewed singly, printed in black and white, would be unsatisfying since they would lack the strength of contrast to which we are accustomed in monochrome photographs. When the full strength rose is printed on the full strength yellow, and on top of that, we place an impression of the blue in full strength, the result is so near a black as to thoroughly satisfy the average observer, even though the individual impressions may appear pale.

The correct values of yellow, rose-pink, and blue-green, are incorporated with gelatin and coated separately upon sheets of photographic paper stock by the manufacturer. As shipped, this tissue is insensitive to light. It is sensitized as required by the user.

In order to fulfill the requirements of three delicately modelled images in the respective colors, it is essential, first, that the method employed in making the images shall be one that does not produce the slightest fog or clouding of the highlights, or, in other words, that does not put the slightest trace of color where it does not belong, and second, that the three images shall register perfectly when superimposed.[16]

All paper expands greatly when saturated with water. To make the matter worse, it expands unequally lengthwise and crosswise of the roll from which it was cut. To retard this expansion to within the time limits that are necessary for manipulation, we pin the color sheets face down to clean bread boards and thoroughly paint the back of the paper with Duco lacquer, giving three coats and allowing ten minutes time between each. Drying for twenty-four hours renders the cellulose film hard and tough and while it does not completely retard subsequent expansion, the latter is so slow in coming as to enable the subsequent impressions to be made with perfect register.

The next step in the preparation of the tissue is to reverse the color sheets on the same boards, again pinning them down, this time color face up. In the darkroom under plenty of artificial light, the actual sensitizing is to be done.

The very essence of the success of this process lies in the ability to secure complete solubility of the unexposed gelatin.[17] The time required for drying of the sensitized tissue has much to do with this. If drying is delayed for many hours, it is impossible to get rid of the thin films of partially insoluble gelatin which clouds the highlights and shadows alike with color in the wrong place.

We therefore use as the sensitizer the following method: Make up a stock solution of pure ammonium bichromate of 6% strength, or 6 grams per 100 cc. of distilled water. This keeps indefinitely in

[16] In the orthodox methods of operation in which single prints are made by either the carbon or the bromoil process there is little or no need to be concerned with either of these points. But in trichrome printing, the slightest falsification in either respect is instantly detected. Hence the reason for our technique which anticipates both requirements and which has been found to be vastly more reliable than the usual methods found in the manufacturer's manual of instruction.

[17] It has been recommended that the color sheets be immersed in the sensitizer for a minute or so then hung up to drain and dry. Our experience has been that this is eminently satisfactory for monochrome prints but wholly unreliable for color work since it is impossible to dry with sufficient rapidity to avoid impairment of solubility.

a brown bottle if stored out of the light. To one volume of this stock solution, add two volumes of denatured alcohol, stirring thoroughly, and mixing only sufficiently to coat the paper to be used that same day or the following day.

Working in full artificial light, but being careful to have no daylight in the room, paint the color sheets with a very soft, high quality camel's hair brush in even strokes, going once across and once longitudinally and taking care to leave no bare spots. Put that sheet aside while doing the next and after going over all sheets with the first coat, repeat the operation. If care is taken to have sufficient solution in the brush, there will be not the slightest tendency to streak in the sensitization.

Set the boards up in a rack and place in the breeze of an electric fan. Within twenty minutes the paper is dry and ready to use. Drying should be done in complete darkness. When dry, remove from the boards and assemble in sets of first yellow on the bottom, then red, and finally blue on top, clipping the three sheets together with a pin stapling machine at the extreme edge. Finally store in a large envelop or light tight box. The sensitized paper may be handled in strong artificial light but should not be exposed to daylight for even a few seconds. It will keep its solubility for but two or three days only.

An important point is to have the sensitizing solution not above 70°F at the highest, and the room in which the painting is done should not be above that temperature, or streakiness is almost sure to ensue. If the temperature is too high in the daytime, the only recourse is to do the work in the evening or very early morning.

The next step is the preparation of the negatives for printing which means that we must have register marks on them. Laying the A plate on a white card, letter with India drawing ink on the bottom margin the word "blue" together with any other data that will assist in identification of the subject. Wipe off the wax pencil numeral that was placed there for temporary identification, and clean the back thoroughly. Repeat with the other negatives, marking them, "red" and "yellow" respectively.

With a strong and sharp draftsman's bowpen compass adjusted to draw the finest ink line, place the pin very carefully at the intersection of the cross-hairs photographed on the plate, and bisect the extremity of the vertical hairline with an ink line half an inch long. Swing the compass and repeat on the other extremity. Do this with each of the three plates, taking the utmost care to center the compass carefully, and to avoid changing the radius of the compass adjustment, since upon the care with which this operation is done depends the subsequent success in registration.

Place the blue negative upon a sheet of glass illuminated from below, and above it register the red and finally the yellow plate, to check the accuracy of the compass work and also to insure that the images are registered by the camera. If they are not, they must be made over, using greater care throughout.

If everything checks, prepare some strips of lattern slide binding tape cut into 8-inch and 10-inch lengths. Punch $^3/_8$-inch holes in the center of the 8-inch strips, and stick them down on the margins of the negatives so that the hole in the tape coincides with the registry cross at the extremity of each cross-hair. Finish by taping the longitudinal margins to provide a strip of opaque tape half an inch wide around each negative at the edge, with a transparent opening at each register cross.

We are now ready for the actual printing, for which we prefer an arc lamp. Daylight is too uncertain and too rapid. A double arc flood light may be made if one cannot afford to purchase it, and nine amperes on two series arcs is plenty. The arc and the printing frame should have a definite and fixed distance apart, so that once an exposure has been determined there will be no variables.[18]

To prepare the paper for printing, make a template that locates the position of the register crosses on the negatives on a sheet of cardboard and punch holes in it to correspond. Then using this template as a guide, locate and punch corresponding holes in the sets of tricolor sensitized paper. Now separate the sheets by withdrawing the wire staples and lay the yellow sheet gelatin or color-side down upon the face of the yellow negative, registering the holes in the paper with those in the negative tape. Place the back in the printing frame, closing one side and with the other open, very carefully and with an exceedingly sharp and hard drawing pencil continue the negative register marks upon the back of the paper. Close that side of the frame and open the other to repeat the operation. Be very careful not to shift the paper in closing the frame, and avoid touching the gelatin side of the color sheet with the fingers.

Place the frame before the arc lamp and while it is printing, prepare the red and blue sheets likewise on their respective negatives, placing the register marks on them as described. When the yellow print is

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[18] If the negatives are made as has been described, their density will be such that complete exposure will be effected in exactly eight minutes for all three negatives, if the frame is placed twenty-four inches from the twin arcs. In hundreds of negatives this rule has but three exceptions, and these require ten and eleven minutes for correct exposure. Of course, variations in the amperage of the arc from that of the author will bring corresponding initial corrections, but once the ratio is found, the practice is one of great exactitude and certainty.

exposed, substitute for it the red negative frame and while that is printing, we may get the yellow sheet transferred to its final support.[19]

The final support we prefer is opaque white celluloid with a mat but perfectly smooth surface. The sheet may be of any desired thickness, ten-thousandths of an inch being preferable. Cut the celluloid somewhat larger than the color sheets and clean the mat surface with cold water and cleansing powder to remove all grease and finger marks. Immerse the celluloid in a clean tray of distilled water, not tap water because of entrapped air, and have the temperature of the water not over 70°F.

Have ready on the work table a sheet of plate glass two feet square and upon this a doubled sheet of lintless photographic blotting paper. Have also a roller squeegee handy.

Remove the yellow print from the frame and quickly immerse it face up in the distilled water breaking any bubbles that may form immediately with the finger tip. Start counting seconds as soon as the color sheet is immersed and when you have counted fifteen seconds, quickly turn the color sheet over and bring into contact with the celluloid under water. Approximately center the sheet, remove both, and place upon the blotter, squeegeeing into firm contact with the roller. Keep counting during all of this operation and after you become proficient, the squeegee will have been applied at the count of thirty seconds.

Lift the blotter cover and continue the pencil register marks from the paper to the celluloid through the punch holes, using the sharpest point and hardest pencil you can obtain. Immediately place the print and celluloid between clean blotters in a letter press and leave for five minutes. Meantime have an enameled tray of tap water heating upon an electric hot plate.

By this time the red print will have been exposed and the blue may be placed before the arc. Be sure that the register marks have been

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[19] Herein we see a modification in the usual process for trichrome printing and one that saves a day's time. The usual method is to strip each color sheet upon a temporary waxed support, develop in hot water, and finally superimpose successively in register upon a final support. This method is perfectly workable, but it has certain objections among which is the fact that it is extremely difficult to tell when all of the soluble gelatin and pigment is removed when looking at a print on a transparent support and, second, the wax coating limits the temperature to which one can go in development without losing detail in the highlights, the most important part of the color print. Furthermore, it has been found impossible to transfer all three images in one day since each must dry before the next is applied. Our method gives the advantage of a firm attachment to the final support during development, the control of color depth and clarity of highlight for each successive impression on the last, and it gives a finished color print in half an hour.

carefully duplicated on all prints before removing paper from the frame. Also place a check mark at the top of each sheet and one on the celluloid to show how successive prints go down since there is not the slightest sign of an image visible on the prints until after development.

By this time the five minutes will have elapsed and the yellow print is ready for development. Bring the water in the tray to between 115 and 120°F and place on a table under a good bright artificial light. Do not work in daylight. Place a second tray on the stove to heat while using the first.

Quickly immerse the celluloid and attached paper in the hot water and break bubbles. After two minutes or so, the yellow pigment will be seen to ooze out at the edges of the paper. Holding the celluloid under water with one hand, grasp the color sheet firmly at one corner with the fingers, digging the index finger nail right into the paper, and pull off with one gentle, but decisive stripping motion. The celluloid will be covered with a smeary mess of yellow pigment with still not a sign of a picture. Rock the tray back and forth for a few minutes and the soluble gelatin will dissolve slowly, gradually bringing out the picture in full detail. Wash the hot water back and forth until every vestige of soluble gelatin is removed and the yellow print stands out in a clear lemon yellow against the white celluloid. When you think it has been fully developed, leave it there for a while longer, since it takes much experience to judge when all of the insoluble has been removed.

When clear, remove from the hot water and rinse briefly in clean cold water. Using an old blue filter, of the C series, examine the picture through the filter to see if the highlight detail is preserved. The yellow will look black through the filter, but is almost unrecognizable by Mazda light, especially in the delicate highlights.

If the highlight detail is intact, exposure was correct. If the shadows are muddy and entirely filled up, the negative was too harsh and "contrasty." If highlight, halftone, and shadow details are there as seen through the blue filter put the yellow print on the celluloid in a tray of 3% solution of ordinary alum in distilled water, for a minute or two and then put it back in the clean cold water.

Take the red print from the frame and immerse it in the tray of distilled water face up, starting to count as before. At fifteen seconds, lift the red print out for a moment and bring it face down upon the celluloid with its yellow image under the water just long enough to get approximate register of the pencil marks. Keep counting, and in about twenty or twenty-five seconds remove the two and finish the job of close register on the blotter, immediately squeegeeing the prints into contact as soon as register is perfect. If awkward at first, one may run

into forty or fifty seconds before he can squeegee in register. The cellulose impregnation of the tissue retards expansion for at least sixty seconds. Without it expansion starts at ten seconds.

After five minutes between blotters in the press, the red impression may be developed just as was the yellow. The water need be only 110 to 115°F since the red and blue gelatin is far more soluble than the yellow.

The red pigment must be even more thoroughly developed but it can be seen easily without the aid of a filter. The composite yellow-red print is a brilliant, clean scarlet to orange and clear yellow in its values, and when no muddy deposit of undissolved gelatin-pigment remains, rinse briefly in cold water and place in the alum bath as before. After two minutes place in cold clean water and prepare to transfer the blue print.

Now comes the critical work. If red and yellow do not exactly register it is not easily seen; but if the blue does not register upon them the result will be poor.[20]

There is always a temptation to remove the blue print before it is finished. Leave it in the hot water until the halftones and shadow details appear. There is little danger of over-development, and the author has at times wonderfully brightened the deeper values by placing the apparently finished print in water so hot that the hands can barely stand it without losing a trace of the highlight detail. There is a decided reinforcement of the gelatin image as a result of the successive layers, each hardened in turn by the alum bath and each affording a good grip for the next impression.

The picture will now be there in full color and beauty and it remains only to treat in the alum bath for a few minutes, wash for ten minutes, and hang up by one corner to dry. The image is exceedingly tender until dry, so care should be taken to avoid touching it with anything save water.

When dry, the colors will have dulled greatly and you may be disappointed, but the application of a waxing solution such as the Eastman Nepera waxing solution will bring back the full brilliancy. The print is now finished.

Trichrome Bromoil Technique

For a complete understanding of the art of bromoil printing the reader is referred to any one of the many excellent handbooks available

[20] Perfect register is solely a matter of dexterity and care. If not successful the first time, be more careful and try again. Follow the same procedure exactly as with the red, and try to make each movement with precision. When you come to develop the blue impression on top of the red-yellow you will see the advantage of this simplified technique over the double transfer method.

from dealers in bromoil supplies. We shall confine our remarks solely to the precise technique that has been found dependable.[21]

Three fully exposed and fully developed but delicately modelled bromide prints are made from the separation negatives, the prints being developed in a one to six Nepera solution at precisely 65°F and fixed in the plain hypo bath. The prints are washed for half an hour in running water, being kept separated during the operation, as well as while in the hypo. Fixing should be carried on for fifteen minutes.

The prints are, after washing, blotted carefully with lintless blotter and pinned face up to boards to dry flat. Thumbtacks answer nicely as they tear the paper without stretching it while the stock shrinks in drying. The prints must be marked on the back to identify them as to the respective colors. The register marks will have printed from the negatives on to the paper so that feature is automatically taken care of.

When the prints are thoroughly dry, turn them face down on the illuminated glass and in back of each register mark, place a drop of the Nepera waxing solution. This renders the paper stock so highly translucent that the mark can readily be seen through it. Now pin all three down to the boards, emulsion face down, and paint the backs with three successive coats of the Duco lacquer just as was done with the carbon tissue. Dry for 24 hours. This renders subsequent expansion equal in all three prints.

To prepare for bromoiling, take the yellow print only, leaving the

[21] The supplies needed are preferably a bromoil transfer roller press, or if that cannot be afforded, a substantial laundry wringer, hand operated, will serve although it fails in the fullest extent by having insufficient pressure. Still excellent results have been obtained with one on prints not larger than eight inches wide. One or two large fitch stag's foot brushes and one very small one 1/4 inch in diameter are required. These are special brushes prepared for the purpose. A supply of bromoil paper, a bottle of Sinclair Bleach, Nepera solution for developing the paper, and a plain hypo solution of 12 oz. hypo to 60 oz. of distilled water, complete the photographic supplies. The inks are special ones prepared for the purpose and sold by dealers as tricolor blue, red, and yellow bromoil inks. No substitutes in the way of shades or color values will answer since the transmissions of the three inks must be correctly balanced.

A word about the inks is timely. The author has found such difficulty in getting a dependable supply of each color in the United States that he has finally made his own. If any reader should have trouble in procuring the true tricolor inks the author will be glad to assist him either in finding a source of supply or to tell him how to make the ink, but space prohibits this here.

The primary causes of trouble in Tricolor Bromoil Transfer are (1) improper colors of inks, or inks that have drier in them; (2) lack of cleanliness in the various steps, such as the use of trays that have been used for other purposes; (3) lack of thoroughness in fixing and washing, due to prints sticking together, etc.; (4) lack of systematic procedure in manipulation so that the time used in the treatment of the three consecutive prints varies widely.

red and blue for later, and place in water at 70°F for ten minutes. Remove and blot off under the squeegee, using only lintless photographic blotter. Make up the bleaching solution as directed on the label of the bottle, and immerse the damp print quickly, immediately breaking any bubbles that form. When the black image has turned to pale green in the highlights and yellow-brown in the shadows, the print is half finished. Keep rocking the tray until the yellowish-brown of the shadows has given way to a clean green-gray but very faint image of the original picture. Remove from the bleacher and wash in running water for ten minutes then place in fresh hypo from the stock solution originally prepared. Throw away each trayful of hypo when you are through and do not attempt to fix bleached prints in hypo that has been used for the original fixation. Hypo is cheap and easily prepared.

Five minutes in the hypo, followed by half an hour's soak in water at 70°F perfectly conditions the print for inking.[22]

Place the wet print face up on the plate glass of the work table and blot it off with the lintless blotter using the roller squeegee. Be sure there are no droplets of water around the edge since these will cause trouble later.[23]

If the ink is correctly conditioned by the maker, it will need no thinning when spread upon a sheet of clean glass with spatula. It should be thin enough to spread readily into a smooth, slick layer. If it does not, use ever so little of Sinclair's medium as a thinner, but every effort should be made to use as little as is consistent with easy inking.

The technique of brush work cannot be fully described here but is covered thoroughly in the various handbooks. Suffice it to say that the brush is grasped with a light but firm touch and patted gently in the thin ink layer, then patted out on clean glass until the spot is smooth. Then the brush is applied to the print in successive pats until the surface is covered. Continued brush action brings out the full detail of the original image in the color of the ink which is

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[22] Let us caution against trying all of the various tricks that are recommended to get artistic effects in monochrome bromoil transfer. These include soaking in warm water, hot water, dilute ammonia baths, etc., and are eminently satisfactory for pictorial work but productive of endless grief in trichrome printing. The object is to get three successive impressions of a well-modulated image having precisely the same values of highlight and shadow contrast. If you fail to do that, the result may be either weird or very possibly, exquisitely beautiful, just as an artist's painting may be, even though it be far from a reproduction of his model.

[23] Beware of the chamois skins, lintless linens, etc., that are recommended for removing water for they are productive of an exasperating collection of fine hairlike dirt patches while inking up. In the course of bromoiling some five hundred prints the author has not had to waste one minute a print removing dirt since he discarded the alleged lintless fabrics in favor of clean photographic blotter.

yellow in this case. The only way to master this operation is to perform it.

The yellow print, when inked, is laid face down upon a sheet of etching paper which is to receive the final picture. Be careful to see that the register marks are clearly inked and well defined before transferring.

Placing the etching paper and the bromoil print between blotters and these between two perfectly smooth sheets of engravers' zinc, run the pack through the press several times back and forth, increasing the pressure slightly each time. The pressure never need be so great as to make the press difficult to turn.

Remove the press pack, and before lifting the bromoil from the paper, run a pencil mark from the bromoil paper to the transfer paper to provide for a second impression from that same sheet in register. It will be found that the yellow ink has been transferred from the bromoil to the etching paper just as a half tone plate transfers its ink to the printer's paper in a press.

Carefully go over the faint yellow impression of the register marks with a hard, sharp pencil to aid in subsequent registry of the red and blue impressions. Place the bromoil print with its faint residue of yellow ink upon a second etching sheet and run through the press again, but give a very light pressure this time or the paper will stick to the gelatin.

After this faint impression is completed, place the bromoil back in the water for a few minutes and repeat the inking up, transferring the fully inked print to the impression that bears the faint yellow image and registering by means of the pencil marks on the back. After this transfer, the reason for the initial faint impression will be seen. The yellow picture will this time be rich and well graded and will be devoid of the flatness that characterized the first one. Repeat the operation for as many yellow impressions as are desired, and when finished, go back to the first one giving it the residual ink remaining on the bromoil which will complete its shadow strength.

If the yellow impressions have been made in the morning they will be sufficiently dry by the afternoon to take the red. The printing technique is exactly the same as for the yellow, a faint shadow impression being made from the residue of ink left after each full inking. This method gives a wonderful richness and depth to the coloring without building up so much ink as to render the layers opaque and muddy.

Try to have the temperature of bleach, water, and hypo the same as was used on the yellow prints.

Registry of the red on yellow is easily accomplished by superimposing on the glass illuminated from below, the spot of waxing solution having made the register marks plainly discernible through the paper.

The blue impression had better be made the following day since transfer is much easier if the successive ink layers are permitted to soak into the paper.

The keynote of success and this means richness of coloring, is to learn to apply the ink so that there shall be no film of color where it does not belong. This is easily accomplished by going over the entire print after finishing the inking, by lightly tapping with a perfectly clean brush which removes the color from all fully swollen portions of the gelatin.

The trichrome bromoil transfer becomes increasingly beautiful with age, the ink seeming to soak into the paper after several days, the mellowness and richness increasing thereby.

VITREFRAX CORPORATION
LOS ANGELES, CALIF.

EFFECT OF REDUCING GASES ON THE TRANSVERSE STRENGTH OF FIRECLAY BRICKS[1]

By A. E. R. Westman[2]

ABSTRACT

It was reported that fireclay brick, when heated in the presence of carbon monoxide, were disintegrated by the progressive deposition of finely divided carbon at the "iron spots" in the brick. The conditions necessary for the occurrence of this phenomenon were not definitely known, although the known reversibility of the catalytic reaction around 650°C and the outcome of small scale experiments indicated that disintegration would not occur above this temperature. To obtain more definite information on this score, the effect of city gas at 550°C and 1100°C on the transverse strength of three brands of fireclay brick was determined. No significant changes in strength occurred at 1100°C. At 550°C two of the brands suffered very significant decreases in strength, but the other brand was unaffected, although it had the highest iron content.

Introduction

Object of Experiments

It has been known for some time that, under certain conditions, fireclay brick, when heated in the presence of reducing gases containing carbon monoxide, are subject to disintegration brought about by the catalytic deposition of finely divided carbon at the "iron spots" in the brick. Such disintegration has been observed in certain zones in blast furnaces and has been produced in the laboratory by the use of pure carbon monoxide. Several writers have discussed this problem, *viz.*, Holgate,[3] Cramer,[4] O'Harra and Darby,[5] Nesbitt and Bell,[6] Phelps,[7] and others;[8] and it has been made the subject of several series of experiments. Although

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[1] This paper covers results obtained in connection with an investigation carried on in the Eng. Expt. Station, Univ. of Illinois, the detailed results of which are published in *Bull.*, No. 179, "An Investigation of Checker Brick for Carbureters of Water Gas Machines," by C. W. Parmelee, A. E. R. Westman, and W. H. Pfeiffer. This article is published with the permission of the Director of the Engineering Experiment Station.

Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Refractories Division.) Received April 18, 1928.

[2] Research Associate, Ceramic Eng. Expt. Sta., Univ. of Illinois, with the help of W. H. Pfeiffer and A. J. Paul.

[3] T. Holgate, "Action of Gases on Fireclay Brick," *Tonwaar. Ind.*, **10**, 148 (1906).

[4] E. Cramer, "The Destruction of Fire Brick by Blast Furnace Gases," *Tonind. Ztg.*, **31**, 1383 (1907).

[5] B. M. O'Harra and W. J. Darby, "The Disintegration of Refractory Brick by Carbon Monoxide," *Jour. Amer. Ceram. Soc.*, **6** [8], 904–14 (1923). A number of other references are given in this paper.

[6] C. E. Nesbitt and M. L. Bell, "Firebrick Disintegration" *Brick Clay Rec.*, **62**, 1042–43 (1923); *Iron Trade Rev.*, 1603–1607 (1923).

[7] S. M. Phelps, "Discussion of the Disintegration of Clay Refractories in Iron Blast Furnaces, *Jour. Amer. Ceram. Soc.*, **7**, 716–17 (1924).

[8] "Studies of the Effects of Chlorine, Sulphur Dioxide and Carbon Monoxide upon Various Refractories," Amer. Refract. Inst., *Tech. Bull.*, No. 9, March (1927).

the conclusions of the different writers disagreed in some respects, there was considerable evidence to show that the action was catalytic and reversible and that it did not take place readily at temperatures above 600°C. This conclusion was in agreement with the known fact that the chemical reaction $2CO=C+CO_2$ was reversible at about 650°C, carbon being formed in large quantities only at temperatures below this. A résumé of the available information concerning this reaction has been published by Stansfield.[9]

In connection with an investigation of checker brick for carbureters of water-gas machines,[10] it was considered advisable to determine the effect of carbureted water-gas on some brands of fireclay brick which were commonly used for checkers, as it was possible that the failure of checker brick could be attributed to disintegration brought about in a manner similar to that described in the foregoing. Since it was known that the transverse strength of a fireclay brick suffered a very marked decrease when any cracking occurred, it was decided to use strength measurements in determining when disintegration had taken place in the experiments. The gas used in the experiments was taken directly from the city supply system and had an analysis which approximated the following:

	Per cent by volume
CO_2	2.0
O_2	0.5
Illuminants	12.0
H_2	20.0
CO	20.0
CH_4	16.0
N_2	29.5

Preliminary Experiments

Three series of preliminary experiments were carried out, in which small specimens cut from fireclay brick were packed in crushed coke in saggers and heated in an atmosphere of city gas. In the first series of experiments, specimens 1 by 1 by 9 inches were used and transverse strength measurements were made; in the other two series, compressive strength measurements on specimens $2^1/_4$ by $2^1/_2$ by $4^1/_2$ inches were used in detecting disintegration. Of eight brands which were tested in this way, three showed definite disintegration by actual shattering which occurred when they were heated in city gas at 550°C for 122 hours. The other brands showed no unmistakable disintegration at this temperature and none of the brands suffered shattering when heated in city gas at 1100°C. An analysis of the values obtained from the strength measurements showed that the sampling errors were so great when such small specimens were

[9] Preprint 44, Amer. Electrochem. Soc., Philadelphia Meeting, April (1927).

[10] "An Investigation of Checker Brick for Carbureters," *Jour. Amer. Ceram. Soc* 9 [5], 290–97 (1926).

used that little significance could be attached to the changes in strength which were calculated. Accordingly, a further series of experiments was carried out, in which whole brick were used for specimens and samples of sufficient size to give significant results were employed. These experiments are described in the following.

II. Final Experiments

Brands Used Three brands of brick, which will be called *A*, *B*, and *C*, were used in these experiments. They were chosen because their properties were well known from previous work and because the preliminary experiments had indicated that they were typical of a large number of brands. A summary of their properties is given in Table I. It will be seen that they differ considerably in structure and method of manufacture.

Selection of Samples Sixty bricks of each brand were chosen at random from larger samples which had been obtained for use in the service tests. The lots of sixty were "shuffled" repeatedly and then divided at random into three samples of twenty. In the case of each brand, one of these samples of twenty was used in determining the mean transverse strength of the brick after they had been heated in reducing gases at 1100°C, another in determining the mean strength of brick after heating in reducing gases at 550°C, and the third sample in determining the mean transverse strength of the brick after reheating to 1125°C.

TABLE I

Brand	Manufacture	Porosity (%)	Permeability* (cc./sec./cm.pr.)	Softening point† (cones)	Firing temperature† (cones)	Analyses†				
						SiO_2	Al_2O_3	Fe_2O_3	TiO_2	CaO · MgO Alk.
A	SMR	16.7	0.68	29–30	9–11	64.60	30.13	2.73	1.52	1.52
B	SMR	16.7	1.31	32	10–12	55.20	38.87	2.21	1.48	1.78
C	SDP	14.8	0.27	32–33	8	54.10	41.20	2.02	1.83	1.29

* Permeability of a standard straight brick to air, parallel to $2^1/_2$-inch dimension of brick, under a head of 1 cm. water. See Univ. of Illinois Eng. Expt. Sta., *Circ.*, No. 14.

† Data submitted by the manufacturers.

Mean Transverse Strength of Reduced Bricks The first samples of twenty for each brand were packed in coke in large flue tiles and heated in an updraft, gas-fired kiln at 1100°C for 56 hours. During this time 4010 cubic feet of city gas were passed through the tile, the gas being introduced through a porcelain tube. The second set of twenty samples was treated in a similar fashion with 17,880 cubic feet of gas at 550°C. In both these experiments considerable difficulty was encountered in controlling the temperature of the kiln due to the unusual setting. In addition, in the experiment carried out at 1100°C, carbon deposits, formed by decomposition of hydrocarbons in the gas, tended to block the porcelain

tube, by means of which the gas was introduced into the flue tile, thus interfering with the flow of gas through the tile. This difficulty was not encountered in the experiment at 550°C. In both runs, however, the brick were subjected to more severe reducing conditions than they would ordinarily meet in practice and any pronounced tendency toward deterioration should have been reflected in the strength measurements. The transverse strength of the treated brick was determined in accordance with the A.S.T.M. method for building brick (C21–20), the brick being broken on edge instead of flat, however, in accordance with the procedure which was adopted for the main investigation. The arithmetical mean of the transverse strengths for each sample was calculated and is reported in the tables which follow as "Mean strength (reduced)."

TABLE II

EFFECT OF REDUCING GASES AT 1100°C

Brand	Mean strength reheated 1125°C (lbs./sq. in.)	Mean strength reduced 1100°C (lbs./sq. in.)	Difference (per cent of mean strength reheated)	Significance of difference* (P/o)
A	1259	1145	−9.1	23
B	1315	1220	−7.2	32
C	786	790	+0.2	92

* P/o gives the number of times in 100 trials that differences equal to or greater than those reported may be expected to arise solely from errors in sampling and measurement.

Mean Transverse Strength of Reheated Brick

The third set of samples of twenty bricks of each of the three brands was heated in a similar fashion to the brick which had been treated with city gas and was held at 1125°C for ten hours, oxidizing conditions being maintained. Their mean transverse strengths were determined and reported in the tables as "Mean strength (reheated)."

III. Interpretation of Data

Effect of Reducing Gases at 1100°C

Table II affords a comparison of the transverse strengths of brick reheated at 1125°C with the transverse strengths of brick reduced at 1100°C. The differences are reported as percentages of the strengths of the reheated bricks. For each difference a value of P/o is given.[11] This value gives the number of times in one hundred such experiments that differences equal to or greater than that reported would be expected to arise wholly from errors in sampling and measurement, the reducing gases having no effect. Thus, for brand A, if the reducing gases have no effect and we were to repeat the experiments one hundred times, we

[11] The values for P/o were calculated on the basis of "Student's" Small Sample Theory, the plan of Fisher being followed. *Cf.*, Statistical Methods for Research Workers, by R. A. Fisher, Oliver, and Boyd, London (1925). (Biological Monographs and Manuals, V.)

would expect differences in mean strength of 9% or greater to arise in twenty-three of these experiments, due to sampling errors and errors of measurement. The higher the value of P/o, the lower the significance of the reported difference. We have no reason to conclude from the data given in Table II that reducing gases exert an appreciable effect on the strength of fireclay brick at 1100°C as the differences found experimentally are small and of practically no significance.

TABLE III

EFFECT OF REDUCING GASES AT 550°C

Brand	Mean strength reheated 1125°C (lbs./sq. in.)	Mean strength reduced 550°C (lbs./sq. in.)	Difference (per cent of mean strength reheated)	Significance of difference* (P/o)
A	1259	1158	−8	20.0
B	1315	966†	−27	0.7
C	786	448‡	−43	0.006

TABLE IV

INFLUENCE OF TEMPERATURE

Brand	Mean strength reduced 1100°C (lbs./sq. in.)	Mean strength reduced 550°C lbs./sq. in.)	(Difference (per cent of mean strength reduced 1100°C	Significance of difference* (P/o)
A	1145	1158	+1	85.0
B	1220	966†	−21	6.4
C	790	448‡	−43	0.023

* P/o gives the number of times in 100 trials that differences equal to or greater than those reported may be expected to arise solely from errors in sampling and measurement.
† One brick was shattered by the deposition of carbon.
‡ Five brick were shattered by the deposition of carbon.

Effect of Reducing Gases at 550°C

Table III gives data pertaining to the effect of city gas at 550°C. Interpreting the values of P/o as before, it will be seen that the brick of brands *B* and *C* suffered a significant decrease in strength when exposed to city gas at 550°C, whereas the strength of the brick of brand *A* did not change significantly. Since, in addition, some brick of brands *B* and *C* actually disintegrated in the experiment, showed a characteristic accumulation of carbon at the iron spots and cracks which radiated from these spots, there can be little doubt that deposition from the gases was responsible for the loss in strength of these brands. It is of interest to note that the iron contents of brands *A*, *B*, and *C* are 2.73, 2.21, and 2.02% respectively, so that a high iron content does not necessarily indicate susceptibility to attack by reducing gases.

Comparison of Effects at 1100°C and 550°C

Table IV gives data which indicate the influence of temperature on the reaction causing disintegration. They show that in the case of brands *B* and *C* the mean strength of samples of brick reduced at 550°C is significantly lower than that of brick of the same brand reduced at 1100°C. The data for brand *A* show no significant difference. This

leads to the conclusion that the reaction which causes the disintegration of bricks of brands *B* and *C* proceeds more rapidly at 550°C than at 1100°C.

IV. Summary

Experiments Experiments have been described in which the effect of city gas (carbureted water-gas) at 550°C and 1100°C on the transverse strength of three brands of fireclay brick was determined.

Conclusions At 1100°C the carbureted water-gas had no significant effect on the transverse strength of any of the brands investigated. At 550°C two of the three brands suffered pronounced decreases in strength when exposed to the action of the city gas but the third brand was not appreciably affected. Examination of some of the bricks which actually disintegrated at 550°C showed that carbon had accumulated at the iron spots and that the cracks which caused the disintegration radiated from these spots. The brand having the lowest iron content was the most susceptible to disintegration and that with the highest iron content was not attacked.

The above conclusions are in agreement with the work of previous investigators in which pure carbon monoxide was used and with the published data regarding the reaction causing the deposition of carbon from carbon monoxide. The immunity of brand *A* is probably due to relatively higher firing in the process of manufacture.

Recommendations The experimental procedure which has been described could be improved by finding means for providing better temperature control and a more dependable method for introducing the gas at the high temperatures. The latter could be accomplished by equipment which would allow frequent cleaning of the tube used for the introduction of the gas. Interesting data would probably be obtained from experiments using samples of the same brand of brick fired to different temperatures.

Acknowledgments The funds for this investigation were provided by the Utilities Research Committee which is composed of representatives of the following companies: Commonwealth Edison Co., Peoples Gas, Light, and Coke Co., Public Service Co., of Northern Illinois, Middle West Utilities Co., Chicago Rapid Transit Co., and Chicago, North Shore and Milwaukee R.R. Co.

The writer is indebted to C. W. Parmelee, Head of the Department of Ceramic Engineering, University of Illinois, for his interest and help.

SPRAY ROOM CONTROL WITH A CAMERA[1]

By Harry E. Davis

ABSTRACT

The use of the camera for recording spray room applications is described and its advantages over the old method of keeping actual samples of each spray which soon forms a bulky, dusty accumulation, subject to accident and deterioration. The problem of distinguishing between colors, where several applications are made, remains to be solved by the selection of the proper dyes.

Introduction

For several years past the trend of ceramic finishes for architectural terra cotta has been decidedly away from plain glazes. The demand for limestone and sandstone vitreous slips will perhaps never decrease, but textures, granite, and mottles are being called for on an ever-increasing scale.

The problem arising from the use of any one of these finishes is the difficulty of keeping it uniform, not so much on any particular job, but over a period of months or years during which time it is not being used. If the coverage on the unfired ware were the same as the fired product, the problem would be eliminated, as any fired piece would suffice for a spotting sample. Except in the case of a plain black spot, however, this is almost never true; consequently, some record must be kept of the application before firing if standards of uniformity are to be maintained.

The customary practice in safeguarding this information is to keep a very cumbersome file of unfired samples, which, at best, are quite unsatisfactory. In the case of a plain texture, one sample will suffice, but with granites with two or three applications either one sample must be kept for each spot, or a large sample progressively covered to show each succeeding spot all on one piece. The disadvantages of such a system need hardly be enumerated. The pieces are bulky, fragile, and become nearly worthless if the surface is accidently rubbed a little.

Methods Tried

Hoping to overcome some of the objections of the unfired sample system, it was thought that perhaps Duco lacquer could be spotted onto a wooden plaque, thus eliminating some of the bulk and weight and all of the fragility and rubbing hazard. It was found quite possible to spot the lacquer in the desired manner, but before it had dried (although it dries very quickly) it had flattened out so as to entirely destroy the desired effect.

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Terra Cotta Division.) Received April 16, 1928.

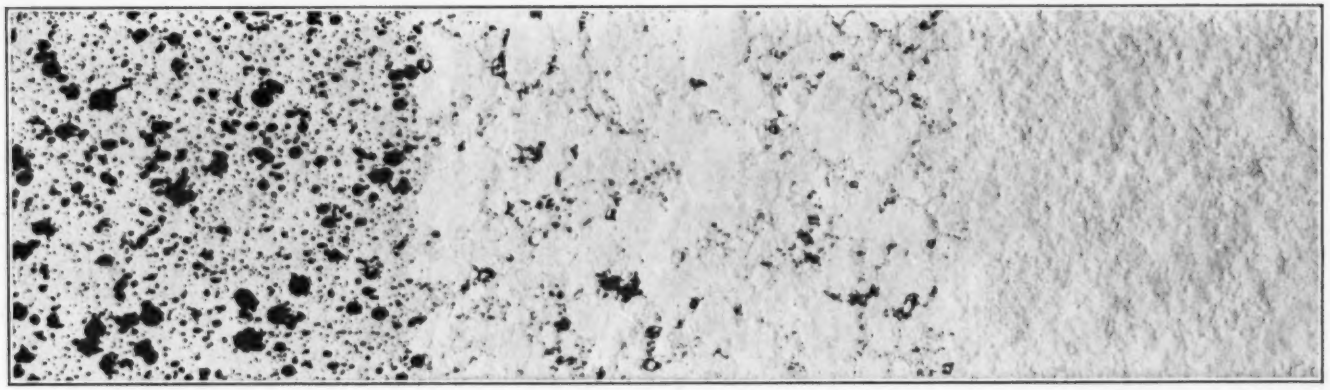

FIG. 1.—Typical granite; black spot on background and two stages of white coverage, using different dyes, which, however, show no contrast on photograph.

FIG. 2.—Typical granite; black spot on background and two stages of white coverage, using different dyes.

At some sacrifice of durability the next method attempted was spotting a thin plaster slip onto a plaster slab. Although such a method could undoubtedly be worked out, it presents its difficulties and is an untidy job. A retarder must be used in the plaster, which is gaged very thin, and the working range is short. Some satisfactory samples were made in this manner, having very much the appearance of a regularly spotted piece of terra cotta. Soluble dyes were used to color the plaster slip, which was all right for a single application, but the application of a differently colored spot over this moistened the two sufficiently to produce a blending of the dyes, rendering the sample worthless. The use of insoluble colors would, of course, eliminate this difficulty, but it seemed only reasonable that, with a little patience, some much simpler and more satisfactory method could be devised. The answer was found in the modeling room, the factory camera.

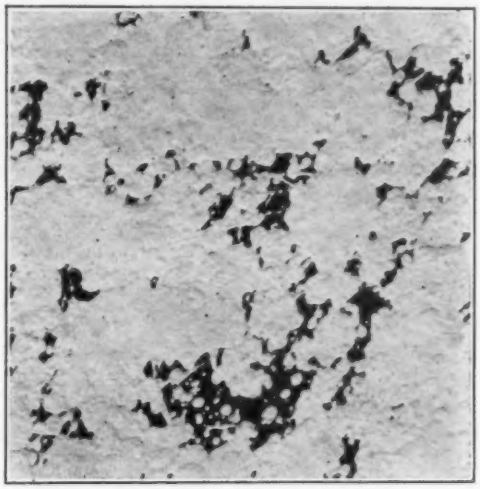

FIG. 3.—Typical texture; one spot on background color.

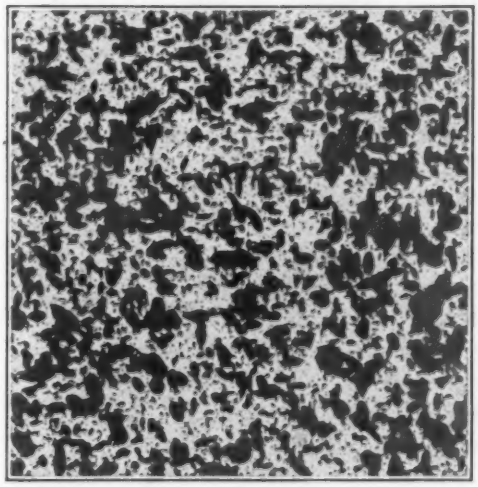

Fig. 4.—Black spot on light background.

Photographing Spray Room Applications

The camera is of a type ordinarily found around terra cotta plants, being a "Seneca" view camera 8- by 10-inch size, not equipped with an especially fine lens but capable of photographing actual size, which is essential for this work. The samples are prepared on an 8-inch ashlar, 10 or more inches long. When the camera is focused so that the full width of the ashlar corresponds with 8 inches on

the ground glass the plate is exposed. It is surprising how the spotting of a texture seems to take form and rise out of the single plane of the photographic print, but such is the case, and a very desirable result is obtained. It is obvious that there must be some contrast between the slip coat and the spot, or between all applications where three or four are used. In this respect, the eye of the camera and the human retina are quite different and without the use of color filters two widely different colors may register the same in shades of black and white on the plate. Orthochromatic plates correct this difficulty to quite a degree, but even the best are more readily affected by ultra-violet, violet, and blue than by the colors toward the red. The natural colors of slips and glazes, with the exception of those heavily loaded with manganese or iron, etc., are usually too similar to present sufficient contrast to the photographic plate or even to the eye, and it is therefore customary in many plants to use soluble dyes to overcome this difficulty. A combination of colors very satisfactory to the naked eye, may, however, result in a very poor photographic record. For instance, a slip dyed pale pink spotted on a gray limestone background is fine for the sprayer's observation, but a picture of this combination is very flat and undiscernible. For this reason the sample prepared for the cameras is frequently sprayed with very dark slip, to obtain sufficient contrast for a good negative.

FIG. 5.—Typical textures; one spot on background color.

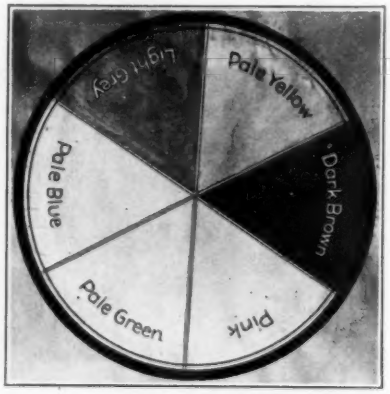

FIG. 6.—Showing "gray" values of varied dye tints.

The foregoing are minor details, which anyone can work out with a little experimentation. Of much greater importance is the fact that satisfactory results may easily be obtained, which are permanent, con-

venient, and accurate. Instead of a pile of heavy, dusty pieces of unfired ware taking up a large amount of floor or wall space and becoming more worthless as the weeks go by, one drawer in a filing cabinet takes care of all the application records for many years. One print is furnished the spray room foreman, and the laboratory file contains the rest. In the case of any special texture or granite, or any slight deviation from one of the standards applied to one particular job, a print of this is attached to the correspondence file for that order. Replacements or additions a few years hence will not depend upon someone's memory or the matching of a piece from the building to insure proper take-up with existing work.

One ashlar has served for many different photographic samples for several months and is still giving good service.

Conclusion

The original intention of this study was to develop a compact system for covering standards, classified according to size and amount of spot which would be applicable to any texture or granite ever developed, but the idea has worked out so satisfactorily and it is such a simple matter to record any number of samples that this has not been considered necessary.

FEDERAL TERRA COTTA COMPANY
WOODBRIDGE, NEW JERESY

THE EFFECT OF LEPIDOLITE IN A HIGH TENSION ELECTRICAL PORCELAIN BODY[1]

By Robert Twells

ABSTRACT

Lepidolite is a lithium mica which has had considerable commercial application in glass and enamels. Its use in porcelain has not been tried to any great extent. This work covers the replacement by lepidolite of the feldspar in a high tension electrical porcelain. The results show that changing the RO of the standard body by molecularly replacing K_2O by Li_2O raises the vitrification temperature of the body, but that replacing feldspar directly pound for pound by lepidolite greatly lowers the vitrification temperature of the body. Lepidolite gives porcelains having a fine appearance and extreme whiteness. The most important property noted is an improvement of the bodies containing lepidolite in resistance to thermal shocks. Owing to its higher cost it is unlikely that lepidolite will be used in porcelains except in small proportions with feldspar to produce bodies having special properties. As hitherto the most important applications of lepidolite will doubtless be in glasses and enamels where full benefit can be secured from its fluorine content and low fusion temperature.

Introduction

In recent years there has been much study of the effect of introducing rare or unusual minerals into ceramic mixtures. Most of this work doubtless remains unpublished, because it has either been very successful or has had no immediate application. In some cases research has proved that certain minerals are of the greatest benefit in improving some products, but so far the work is valueless because commercial quantities of the minerals are not available. The results of such research work, on the other hand, cannot always be predicted. It has happened that rare minerals have been discovered in large quantities, when once the demand has been great enough to force a systematic search. In several instances a mineral which is now the most valuable product of a mine, formerly fattened the scrap pile or was used for road ballast. One need look back only a short time in the field of enamels, glass, porcelain, and refractories to realize the almost revolutionary changes due to the use of compounds and minerals which a few years ago were practically unknown to the ceramist. New work of this nature is always interesting and the results should eventually be published to add to the general information on the subject and to prevent repetition of the study in some other laboratory.

Lepidolite is an interesting mineral which has already had some commercial applications in the field of ceramics; yet it has evidently received no mention in the literature of the American Ceramic Society. Lepidolite is a silicate of potassium, lithium, aluminum, and fluorine, but usually contains in addition small quantities of water,

[1] A contribution from the Research Department of The General Electric Company at Schenectady, N. Y. Received April 9, 1928.

iron, manganese, calcium, magnesium, sodium, rubidium, and caesium. It is classified as a lithium mica with the theoretical formula[2]

$$K \cdot Li\,[Al\,(OH, F)_2]\,Al\,(SiO_3)_3$$

Commercial lepidolite does not contain the theoretical percentages of fluorine and lithium because it usually occurs in isomorphous mixtures of pure lepidolite and potash mica or muscovite which has the theoretical formula K_2O, $2H_2O$, $3Al_2O_3$, $6SiO_2$. "Lepidolite is mostly found as a compact aggregate of very small scales forming scaly granular masses that are many feet thick."[3] It occurs in commercial quantities in Arizona, California, and New Mexico, and in smaller quantities in Colorado, Connecticut, Maine, Massachusetts, and South Dakota. California was formerly the chief source of lepidolite, producing as high as 10,046 tons in 1920 valued at $153,502.[4] It has been reported that the chief source of this mineral is now in New Mexico where a large deposit is available.[5] In "Nonmetallic Minerals" R. B. Ladoo[4] discusses the uses of lepidolite as follows:[6]

> At present the most important application in point of tonnage used is the use of lepidolite and to a less extent the other lithium minerals in the manufacture of glass.[7] It seems to be of particular value in the making of opal and white glass, but it is also useful in the production of flint glass. The value of lepidolite in glass making is probably partially dependent upon its fluorine content in addition to its lithium, both of which are active fluxing agents. Some of the qualities which lepidolite is attributed to impart directly or indirectly to glass are as follows: (1) a lowering of the coefficient of expansion thus decreasing the liability to breakage on sudden heating and cooling; (2) the tendency to reduce devitrification or the production of "scum" in the melt; (3) the production of a harder surface on the finished glass which will retain a luster in moist air; (4) lepidolite glass is less brittle and withstands shocks and vibration; (5) lepidolite increases the index of refraction and hence the brilliancy of the glass; (6) it obviates the corrosion of glass tanks when making opal glass attendant upon the use of cryolite instead of lepidolite as an opacifying agent; (7) lithium minerals are also used to some extent in enamels and glazes.

The trial of lepidolite in a floor tile body has also been mentioned.[5] It is reported that 15% of lepidolite reduced the vitrification temperature of the body enormously, but did not yield as strong a tile as the higher fired body.

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[2] E. S. Dana, A System of Mineralogy, p. 624. James Wiley & Sons, Inc., New York, 6th ed., Colorado Geol. Surv., *Bull.*, No. 12, p. 122 (1917).

[3] Mineral Resources of the United States, II, 9 (1916).

[4] (1) R. B. Ladoo, Nonmetallic Minerals, p. 321. McGraw Hill Book Co., Inc., N. Y., (1925). (2) California Mineral Production for 1920. *Calif. State Mining Bull.*, No. 90, p. 32.

[5] *Ceram. Ind.*, **9** [4], 438 (1927).

[6] See also "Lepidolite in Glass Making," *Nat. Glass Budget*, **36** [7] (1920).

[7] See also U. S. Pat. 1,261,015.

Experimental Work

The present report deals with an attempt to use lepidolite as a flux for high tension electrical porcelain. The lepidolite used was from San Diego County, Calif. R. B. Ladoo gave it approximately the following analysis:[4]

	Per cent
SiO_2	50.18
Al_2O_3	22.81
CaO	0.18
MgO	0.16
Li_2O	4.92
Rb_2O	0.97
Cs_2O	0.30
K_2O	17.48
F	1.20
M_2O_3	0.41
H_2O	2.10
	100.71

Since nothing was known regarding the fusion behavior of lepidolite, C. C. Lin made a very thorough study of the binary system of potash feldspar and lepidolite. (Fig. 1.) Lin's conclusions were as follows:

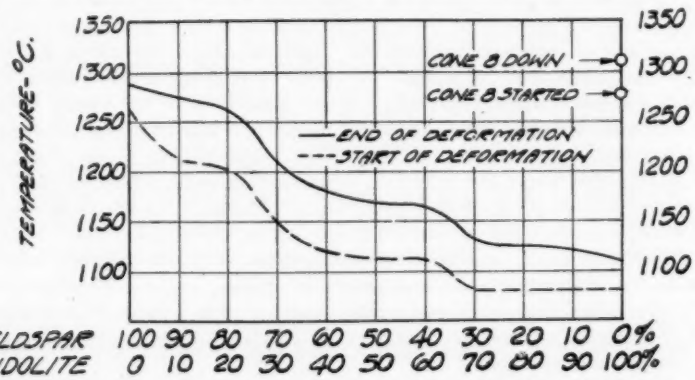

FIG. 1.—A fusion study of the binary system potash feldspar-lepidolite. (After C. C. Lin).

As compared to feldspar, lepidolite is a violent flux. Feldspar deforms at 1290°C (cone 8), lepidolite at 1110°C (cone 02). No eutectics were found in the feldspar-lepidolite series. Mixtures of the two minerals had a longer deformation range than either alone.

A series of bodies was then made up by blunging the ingredients together and drying them out in plaster molds. The test pieces were made by pressing the bodies into steel molds and by jiggering them into test cups.[8]

[8] For a detailed description of the methods used in making and testing the bodies see "The Effect of the Replacement of Free Silica by Alumina and Zirconia in Electrical Porcelain" Robert Twells, Jr. and C. C. Lin, *Jour. Amer. Ceram. Soc.*, **4**, 195 (1921).

Numbers 1, 2, and 3 have nearly the same molecular formula. Number 1 is a standard feldspar body made up for comparison. Number 2 differs in having half of its RO introduced through lepidolite. The RO

COMPOSITION OF THE BODIES

Body Number	Series A			Series B		
	1	2	3	4	5	6
	Per cent					
Feldspar	34.0	14.3	—	—	—	15.7
Lepidolite	—	7.2	14.5	34.0	32.0	7.8
Flint	17.5	27.0	31.4	17.5	19.5	28.0
Ball clay	19.4	20.6	21.6	19.4	19.4	19.4
China clay	29.1	30.9	32.5	29.1	29.1	29.1
	100.0	100.0	100.0	100.0	100.0	100.0

of No. 3 is derived entirely from lepidolite. In No. 4 the feldspar is directly replaced by lepidolite. Numbers 5 and 6 were made later to follow up the result of the first series.

RESULTS OF THE TESTS

Series A (Fired to cone 9½)

Body No.	Shrinkage, Per cent of wet length			Absorption, Per cent of dry weight	Dye test	Modulus of Rupture (lbs. per sq. in.)
	Drying	Firing	Total			
1	3.6	10.2	13.8	0.089	Nonporous	8343
2	3.9	10.4	14.3	0.108	"	8775
3	3.4	9.7	13.1	2.390	Very porous	
4	3.6	7.4	11.0	0.159	Nonporous	

RESISTANCE TO TEMPERATURE CHANGES

Body No.	Number of heats withstood	Fracture	Color	Remarks
1	6.3	Vitreous	White	Properly vitrified
2	13.8	"	"	" "
3	11.6	Rough	"	Underfired
4	7.0	Vitreous	Very white	Overfired, slightly blistered

Series B (Fired to cone 9 down)

Body No.	Shrinkage, Per cent of wet length			Absorption, Per cent of dry weight	Dye Test	Modulus of Rupture (lbs. per sq. in.)
	Drying	Firing	Total			
1	3.3	12.1	15.4	0.03	Nonporous	7,700
5	5.2	7.7	12.9	1.29	Very porous	
6	5.5	10.1	15.6	0.03	Nonporous	7,600

Body No.	Fracture	Color	Remarks
1	Vitreous	White	Properly vitrified
5	"	"	Slightly overfired
6	"	"	Properly vitrified

The results given are the averages of tests on five or more pieces. Tests on bodies 3, 4, and 5 are omitted; since they were not properly vitrified the data might be misleading.

Conclusions and Remarks

When the RO group in the standard porcelain formula is altered by the replacement molecularly of K_2O by Li_2O from lepidolite, the vitrification temperature of the body is greatly raised. When, however,

the feldspar in the standard body is replaced pound for pound by lepidolite, the vitrification temperature of the body is greatly lowered. The use of lepidolite in a body thus requires careful adjustment of the various materials to produce the desired maturing temperature. Lepidolite could doubtless be used as the sole flux to produce a porcelain of low maturing temperature, but its relatively high cost[9] might be prohibitive for this purpose except in localities near a mine. As a small constituent in porcelains for special purposes, lepidolite would prove more useful. Lime, magnesia, and similar fluxes have long been used to give special properties to a body and to decrease the per cent of feldspar necessary for vitrification. These fluxes have the disadvantage of materially shortening a body's firing range. Small percentages of lepidolite used with feldspar should promote the early vitrification of a body without greatly affecting its firing range for lepidolite fuses at a much lower temperature than feldspar; yet its fusion resembles that of feldspar in being slow and without sudden eutectic action. In Series *B* it can be noted that body 6 with 7.8% of lepidolite combined with 15.7% of feldspar, a total of 23.5% of fluxes, produced the same low absorption as did 34% of feldspar in standard body 1. It has been reported that lepidolite bodies tend to be weak. Lepidolite can hardly be expected to produce stronger bodies than feldspar. In this experiment lepidolite and feldspar produced bodies about equally as strong as did feldspar alone. A good property of the lepidolite under test was its freedom from iron. The porcelain bodies produced were unusually white. The most important property noted in the lepidolite porcelains was their good resistance to thermal shocks. This corresponds to the same characteristics already mentioned in lepidolite glasses. Evidently lepidolite also lowers the coefficient of expansion of a porcelain as it does that of a glass.

The writer believes that, as hitherto, the chief practical uses for lepidolite, therefore, will be in the mixtures which are fused practically to equilibrium; *i.e.*, in enamels, glazes, and glasses. In these, its low melting point, and its fluorine content combined with its tendency to give a glass of low coefficient of expansion should make lepidolite of considerable value.

Acknowledgments. The writer wishes to acknowledge gratefully the suggestions of L. E. Barringer under whose supervision this work was done, and the coöperation of C. C. Lin with whom part of this work was done jointly.

16550 Northlawn Ave.
Detroit, Mich.

[9] The cost of lepidolite was reported in 1922 as being about $18.00 a ton F.O.B. the mine in California and $60.00 a ton ground F.O.B. West Virginia. R. B. Ladoo, *loc. cit.*

KILNS, FURNACES, BODIES, AND GLAZES FOR SMALL COMMERCIAL PRODUCTION AND EDUCATIONAL WORK[1]

By Paul E. Cox

ABSTRACT

Drawings and specifications for two small commercial kilns, one small test kiln, and a frit furnace are shown. Glazes suitable for use in the kilns are described. Shales and No. 2 fire clays are suggested for use. Reference is made to ware of commercial quality now being made in kilns of the kind indicated. Two sorts of copper red glazes are discussed and reference is made to the use of salt in effecting changes in the character of glazes. Fritted mat glazes are discussed and endorsed as superior to the raw sort, because of greater flexibility. A kiln atmosphere charged with vapors of common salt effects interesting changes in both the character of glazes and the usual colors produced by the commonly used oxides. A normally glossy, bright, and clear glaze becomes a vellumlike mat when fired in the presence of NaCl under certain conditions. A positive method of producing low-fired copper reds and lusters is described.

Introduction

The data contained in this paper are the result of class work, work done for persons making inquiry about their problems, and the construction of equipment for use in educational work at Iowa State College. Construction work was done invariably by students and therefore the results should appeal to persons interested in ceramic educational work and in small production equipment.

The Frit Furnace

The frit furnace, built on a larger scale would make all the frit needed in pottery production, and is useful for research on glazes and enamels. For whiteware glaze frit, the capacity as shown is about 25 pounds of frit in eight hours.

The shell is galvanized iron and the 30-inch bottom plate cast with a 4-inch hole. Built as shown in Fig. 1, there is insufficient room for a large water vessel under the furnace. In building the furnace from the drawing it will be found that the insulating brick will need to be put in on the flat and not as shown in the drawing in order to make room for the crucible of the size indicated. A smaller crucible could, of course, be made.

The cover of the furnace, *B*, is made from fire clay and grog, and fired and then bound with a galvanized iron band having convenient handles for lifting it.

C, a fireclay tube, may be replaced by a piece of cast-iron soil pipe, which can be easily taken out after filling the crucible.

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[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Art Division.)

The oil burner is shown in conventional form. Gas would do quite as well. The burner openings into the body of the furnace widen the 6-inch opening to permit spread of the flame and to prevent piling up of carbon.

The crucible, *D*, is cast. The body mixture is 50% coarse firebrick grog and 50% clay. The slip was deflocculated and the casting was done with a core covered with heavy cotton cloth. The core was designed to center itself. Three openings permitted filling and escape of air. The core must be weighed down to prevent floating out when the mold is filled.

Small Test Kiln

Figure 3 shows details for the construction of a very convenient and small test kiln. The cover is lifted from the kiln to permit placing of saggers.

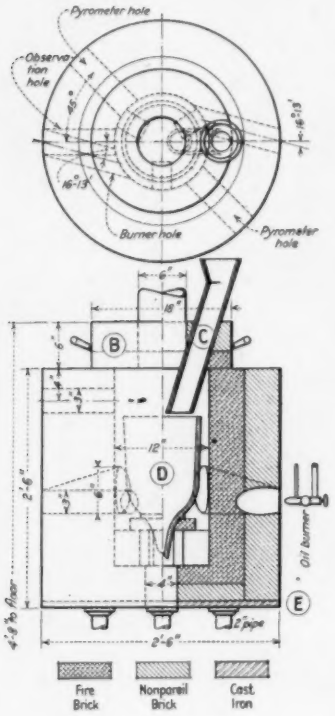

FIG. 1.

A round sagger (10 inches inside diameter) makes the best container for the test pieces. While one deep sagger or two saggers about 8 inches deep can be used, it has been found that it is best to put in one sagger only, bringing up a pile of loosely placed fire brick from the bottom, and to have the sagger made with a cone compartment so that the cones may be seen on the same level as the bottom of the sagger. This will mean that the observation hole must be lowered from the place indicated in the drawing.

Small Commercial Kilns

Figures 4 and 5 show details for a very efficient kiln for the production of commercial ware in a small way.

The three fire boxes are merely holes into the flash-wall spaces. The flames strike first below the floor level of the kiln so that the blasting action of an oil fire will not overheat the ware close to the fires. All outlets are close to the flash-wall with none in the center and experience has shown that the center can readily be heated by radiation. The outside close to the flash-wall is the coldest portion of the kiln. The flash-wall

height should be determined by test and should be high enough to prevent flashing of the goods and low enough to heat the kiln as evenly as possible.

The steel jacket need not be very heavy and, in fact, a heavy grade of galvanized iron would suffice, although steel about $^1/_8$ inch thick is good. The band around the crown should be stiff for when lifting there is a tendency to distort the band. Iron $^3/_{16}$ to $^1/_4$ inch thick is about right.

The kiln is set with six bungs of elliptical saggers and one bung of round saggers. The well-hole in the center of the kiln bottom is best covered over with the special hexagonal tile shown in Fig. 5.

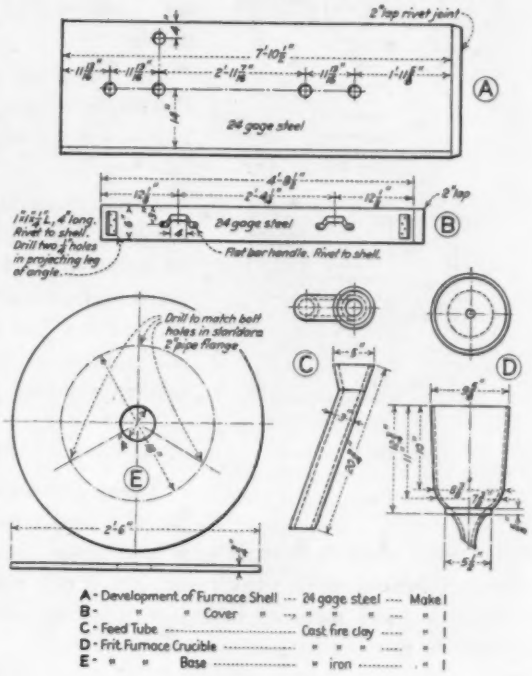
2" lap rivet joint
7'-10½"
24 gage steel
A
4'-8½"
2'-4½"
12½"
2" lap
24 gage steel
B
Flat bar handle. Rivet to shell.
Drill to match bolt holes in standard 2" pipe flange
C
D
E
2'-6"
A - Development of Furnace Shell --- 24 gage steel ---- Make 1
B - " " Cover " --- " " " --- " 1
C - Feed Tube ---------- Cast fire clay ----- " 1
D - Frit Furnace Crucible ---------- " " " ----- " 1
E - " " Base ---------- " iron ---------- " 1

FIG. 2.

Figure 6 shows details for building a kiln to take three bungs of elliptical saggers, to have a wicket, and with the crown permanently in place. Details are shown for an arch over the wicket that makes the blocking up of the wicket less troublesome, as the arch is flat. The angle iron placed over the wicket is not exposed to high temperatures and hence serves to hold the flat arch more securely. The jacket should be of steel as before described for the other large kiln and should be bolted to angle irons at the jambs of the wicket. These wicket jamb angle irons should be carried below the floor level of the kiln house and into a good-sized block of concrete to prevent spread of the kiln at the ground level. If the kiln is built on concrete foundation these angle irons can be run into the foundation.

This kiln can be built much more cheaply than the other, but it is not nearly as satisfactory. It does serve, admirably, however, as a biscuit kiln. This kiln will fire the same amount of ware in the biscuit that the other will fire in the glost. Makers of faience will find these two kilns to be complementary to each other.

Auxiliary Equipment

The kind of oil burner used depends on the air compressing equipment available. For a high pressure burner, a student made the air compressor out of an old gas engine by plugging some of the openings and belting a motor to the former driving pulley on the engine. This made a water-cooled air compressor. It gave all the air needed.

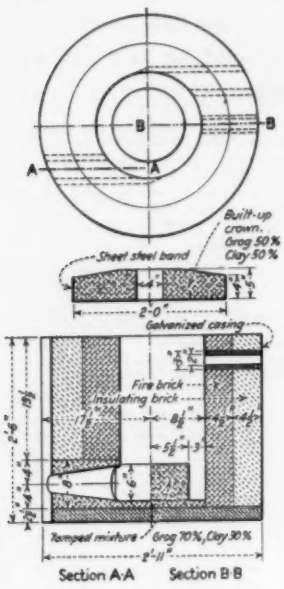

FIG. 3.

Equally good service can be obtained on the larger kiln with soft-blast burners and blowers that run pressures up to about two pounds.

Those fortunate enough to have gas at a reasonable price should use it. It should be understood, however, that where oil is used, high pressure air, 30 to 100 pounds, is needed for convenient oxidation in the larger kilns and is a necessity for proper working of the smaller furnaces.

Bodies Used

There are numerous small plants, commercial and studio, making special bodies from whiteware materials which in many cases could be replaced with decided benefit with shales and No. 2 fire clays. No artificial mixture equals a good natural body in working properties and glaze fit is generally much easier to obtain.

Some Useful Glazes

Edna Carson of Schenley High School, Pittsburgh, Pa., recently decided to develop a mat similar to the Rookwood vellum. R. T. Stull had expressed a belief that the famous Rookwood vellum glaze was produced by setting the goods in wet saggers obtaining results similar to "steamed" glazes on stoneware that had been heated too rapidly in the oxidation stage. Miss Carson's problem was attacked with a glaze that would not reduce easily. The following formula and batch weights were used:

CaO	0.25	Al_2O_3	0.10	SiO_2	1.50
Na_2O	0.25	B_2O_3	0.50		
BaO	0.40				
MgO	0.10				

	Batch weights
Magnesium carbonate (impure)	5.30
Borax eq. wt. 292	73.00
Barium carbonate	78.80
Whiting	24.80
Flint	78.00
Kentucky ball clay	25.70

The Kentucky ball clay was added to the rest of the batch which had first been fritted. At cones 01 to 04 this was a glossy clear glaze, which crazed to some extent when the firing was done in the usual manner. The test pieces were (1) small tiles made from shale from Adel, Iowa, (2) small vases made by casting this same shale, and (3) some wall tile from the U.S. Encaustic Tiling Company.

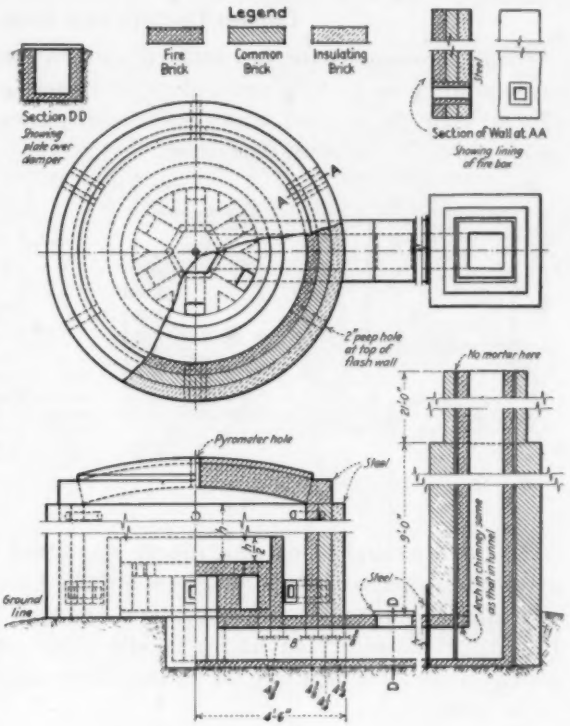

FIG. 4.

Several tests were made in the kiln shown in Fig. 3 by soaking a sagger in water and firing rapidly. A slight scum on the surface was now and then apparent but not enough to be interesting. Generally a perfectly bright and clear glaze resulted. Finally the sagger was soaked in a heavy brine and then the samples were set into this sagger and fired at a rate which completed the whole firing in about six hours. The first test resulted in some specimens that were quite mat, but parchmentlike in texture, some that were quite harsh to the touch, and some that were partly glossy and partly mat.

Finally the plan was adopted of making up a grog plaster well mixed with salt and lining the sagger with a layer of about three-fourths inch thick. If the firing period happened to be correct, a glaze very similar in every way to the Rookwood vellum resulted. If prolonged

there was a curious spotting, brown in color and quite harsh to the touch, which could be scrubbed out, leaving pits like pock marks but not discolored, and if the firing was done over a lengthened period the salt seemed to pass into vapor and away without apparent reaction on the glaze.

There was insufficient time to test the work in larger kilns but the results were very interesting and suggest possibilities with other volatile materials.

Copper Lusters and Reds

Using the same glaze, but stained with carbonate of copper in varying amounts up to 0.10 equivalent and fired first in the large pottery kiln to cone 01, a good many successful pieces of copper luster were produced by the process described.

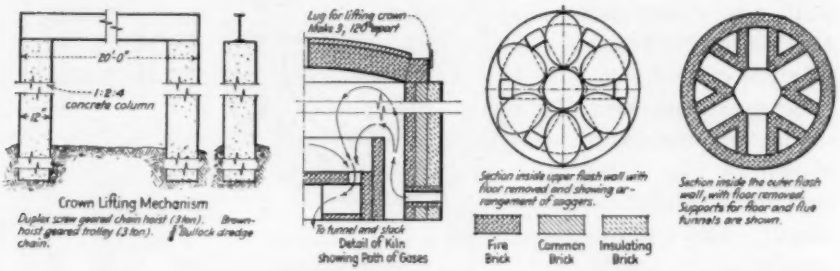
20'-0"
1:2:4
concrete column
12"
Crown Lifting Mechanism
Duplex screw geared chain hoist (1 ton). Brown-hoist geared trolley (3 ton). Bullock dredge chain.
Lug for lifting crown
Make 3, 120° apart
To funnel and stack
Detail of Kiln showing Path of Gases
Section inside upper flash wall with floor removed and showing arrangement of saggers.
Fire Brick
Common Brick
Insulating Brick
Section inside the outer flash wall, with floor removed. Supports for floor and flue funnels are shown.

FIG. 5.

A 6-inch wrought-iron pipe nipple was fitted with two caps, one cap solid, the other with two holes, each drilled and tapped for a $^1/_8$-inch pipe nipple. From one nipple a pipe line was led out of the kiln (see Fig. 3). This pipe line had a needle valve and a funnel. From the other nipple a $^1/_8$-inch line led to the other side of the kiln but was left wide open.

The pieces of ware, already fired to a copper green were then placed in the muffle of the pipe nipple and the top cap screwed down, though not particularly tight.

The kiln was heated up to bright red and the fire turned out. Distillate was then fed drop by drop into the muffle through the needle valve and was distilled out as a smoke. When the muffle had lost all color the treatment was stopped.

The vases were purple to black but this film was easily scrubbed away with water and potters' flint leaving a very satisfactory and cheaply produced copper luster. Since the temperatures reached are far below the slightest softening of the glaze there is no need for any separation

of the ware and they can be placed as tightly together as is convenient.

Some experiments were then made by using glazes of a different color with the copper-bearing glaze placed at points where this luster would be desirable, as for example, to have a red or luster glaze dripping over a suitable shade of blue. Or using a glaze stained with chromic oxide, to have red fruit or a dragon in copper luster, etc. The tests were not carried to an artistic result, but to a point where it was perfectly apparent that more work would yield easy control of the palette to be derived by the process. For example, a bowl was gotten with a drip of copper luster over a blue body and exactly as intended.

The reds produced by the chrome-tin pink stains were altered decidedly. The green was changed to a red tone, since it comes from copper. There seemed to be no particular reason for using a leadless glaze.

A commercial development of art pottery has been started by the writer and Mary L. Yancey, using this method of decorating and employing a wide palette of colors.

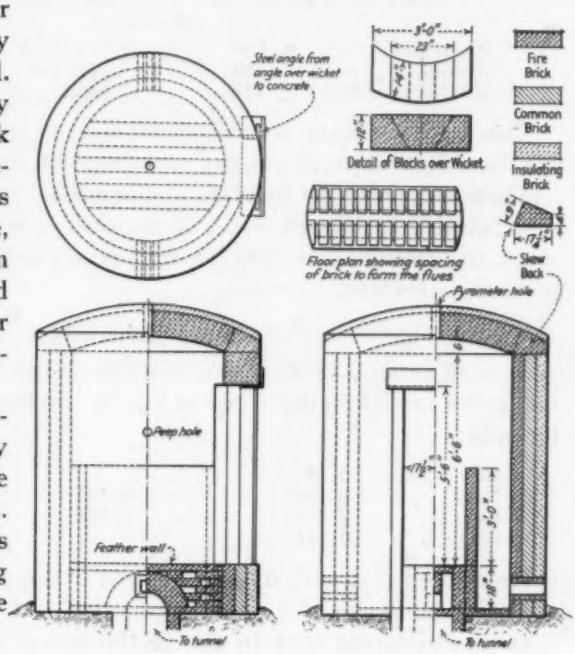

FIG. 6.

Ten-inch cast-iron water pipe has been machined so that it can be placed in the kilns as described in Fig. 3. Each cast-iron cylinder is twenty inches long. On the lower end of each a cast plate has been welded and the top of each is closed by a heavy plate. A handle for lifting has been put on each cover, and as before there are tapped openings for the pipe fittings. These muffles will permit the making of pieces that are quite large.

The literature indicates that for red of good quality much less copper than was formerly used will be sufficient and the results show that the copper seems to be brought to the surface. Streaks of both red and copper, however, are seen together with film colors of many tints.

Cone 2 Tin Enamels

For some years there has been a production of pottery made of the shales and No. 2 fire clays of Iowa. Since these glazes have been used on a wide variety of clays and shales and since they are so free from crazing they are reported here.. The reds and yellows fire best in the bottom fourth of the kiln and the greens and blues in the upper three-fourths of the kiln. The top of the kiln is fired to cone 2 just starting while the bottom of the kiln has a minimum of cone 04 with most of the bottom layer at cone 02.

Glaze Formula

White lead	116	Zinc oxide	12
Whiting	20	Ball clay	21
Clinchfield feldspar	111	Flint	28

The color formula was chrome-tin pink oxide 31, tin oxide 31, Naples yellow stain 31, copper carbonate 11, and cobalt oxide 2.

These enamels stay in place and are ideal for inlaid painting work and painting in faience style. For public school use these glazes are much less troublesome than are mat glazes and the students are quite pleased with them.

Cone 8 Copper Red

A small amount of work was done by a student to produce a copper red in the small kiln described in Fig. 3. He finally chose the following formula:

BaO	0.39	Al_2O_3	0.422	SiO_2	2.82
Na_2O	0.186	B_2O_3	0.288		
K_2O	0.268				
CaO	0.154				

He colored this with 0.08 equivalent of copper oxide obtained from red oxide of copper.

It was apparent that in the production of copper reds of the hard porcelain type the method of dampering is highly important.

Mats of the Fritted Type

Much better and more flexible mats will result from the use of a frit than is possible with raw glazes of the mat type. They seem to have better textures and a greater heat range, and at the same time when piled up to make drips, do not become glossy in the thick places, as do many raw mats.

An especially good mat is made as follows:

Frit

Na_2O	0.154	Al_2O_3	0.077	SiO_2	2.00
PbO	0.462	B_2O_3	0.616		
BaO	0.154				
K_2O	0.231				

	Batch weights		
Clinchfield feldspar	51	Litharge	103
Borax (eq. wt. 292)	36	Potassium nitrate	38
Boric acid	46	Flint	87
Barium carbonate	30		

The glaze is as follows:

						Batch weights	
Na_2O	0.045					Frit	96
K_2O	0.067					Whiting	62
BaO	0.045	Al_2O_3	0.364	SiO_2	1.32	Ball clay	88
PbO	0.223	B_2O_3 0	.180			White lead	23
CaO	0.620					Flint	3

A very beautiful cone 6 soft mat has the following formula:

Na_2O	0.0161				
K_2O	0.1307				
BaO	0.0351	Al_2O_3	0.4536	SiO_2	1.836
PbO	0.2830	B_2O_3	0.0664		
CaO	0.5358				

The frit used was the same one reported in the preceding glaze.

	Batch weights		
Frit	34	Calcined clay	77
Clinchfield feldspar	60	Barium carbonate	4
Whiting	54	Flint	18
		White lead	60

The effect of salt on colored mats by both reducing and salting strongly gives very interesting and unusual effects.

DEPARTMENT OF CERAMIC ENGINEERING
IOWA STATE COLLEGE
AMES, IOWA

American Ceramic Exposition and Meetings

at

THE STEVENS HOTEL, CHICAGO
FEBRUARY 4-9, 1929

EXHIBITS

Exhibits will be all types of manufactured ceramic products made of glass, enamel, pottery, clay, etc., and of ceramic equipment.

PROGRAM

The convention program will be so arranged that part of each day will be devoted to inspection of exhibits. All convention meetings will be held within the Stevens Hotel in close proximity to the Exhibition Hall.

ATTENDANCE

Several trade associations in the ceramic field, in addition to the AMERICAN CERAMIC SOCIETY, will meet at the same time in Chicago, resulting in an aggregate attendance of several thousand delegates. In addition to these, there will be department store managers and agents present. Moreover, the exposition will be open to the public at certain hours each day.

Address all correspondence regarding exhibits to American Ceramic Exposition, American Ceramic Society, Chicago Section, 37 W. Van Buren St., Room 415—Chicago—Tel. Harrison 9462.

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

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Abrasives

PATENTS

Abrasive helicoid. CARL G. OLSON. U. S. 1,670,479, May 22, 1928. A grinding wheel having a helicoidal thread, one side of which is so arranged that the axis of rotation is normal to it, the thread being mounted upon a conical body.

Guards for Carborundum wheels. J. W. WEBB. Brit. 286,494, May 2, 1928. Guards for Carborundum and like wheels are of boxlike form inclosing the whole of the wheel with the exception of part of its upper edge; the front of such box is adjustable horizontally toward its wheel to compensate for wear by a rotatable screwed rod passing through a nut formed on the front. The front also slides upon a channelled guide and guide rods arranged inside or outside the box and is locked in position thereon by nuts. The screwed rod may be dispensed with and the guide rods be made rotatable to engage nuts in the front. The box parts are carried upon upright supports, and one side of the box is hinged to allow access to the wheel, such side being formed with a cap to shroud the end of the wheel spindle. The upper end of the front is forked to inclose the wheel and carries a rest for the work or for the implement used in dressing the wheel. An upper pivoted guard and dust-remover as described in Brit. 285,341 is provided. (See *Ceram. Abs.*, **7** [6], 341 (1928).)

Abrasive wheels. J. R. GAMMETER. Brit. 286,683, May 2, 1928. An abrasive wheel has bonded thereto, on either or each face, by means of vulcanized rubber or other tough resilient material, a plate, whereby a resilient clamping action is obtained by means of plates which secure the wheel to a spindle. The wheel, after the firing employed in its formation, has applied to its faces a liquid rubber compound, the plates are coated with thin rubber, and after application of the plates to the wheel, the whole is inserted in a heated press to vulcanize the rubber; the thickness of the layer of rubber is comparable with the grain size of the wheel.

Grinding and polishing glass and marble. E. ROWART. Brit. 288,196, May 31, 1928. In a machine for grinding, polishing, and washing plates of glass, marble, etc., the plate is traversed or reciprocated beneath grinding tools which are moved in a direction at right angles to that of the movement of the glass. On a frame are supported vertically adjustable counterbalanced parts, to which are pivotally connected frames carrying a rail on which are mounted, by means of wheels, the grinding elements. Each element consists of a frame supporting rollers guided by rails and carrying also the grinding or polishing tools. The tools have interengaging parts linked together to form a continuous chain, so that when driven by motors, the two runs of the chain move across the glass in opposite directions. The glass is mounted on a platform secured to a frame by spring pressed bolts and a series of frames coupled together by parts and bolts are moved beneath the tools on rails, guide rails, and rollers also being provided; the frames are moved by engagement of an adjustable fork with a moving chain. In the polishing operation, the tables may receive, independently of their continuous movement, a reciprocating movement. Adjacent edges of the platforms are cut away and formed with a groove to receive a spring-pressed member which holds a piece of fabric, the upper edges of this piece being coated with an adhesive and projecting between the ends of adjacent plates of glass.

Grinding and crushing. C. E. BRAINARD. Brit. 288,227, May 31, 1928. In a pulverizing mill comprising a rotatable tube or housing and a roller loosely mounted therein formed of several segments which have a sliding and an impact movement relative to each other and to the interior of the housing. In the construction each segment, of which there may be three or more, has 2 flat faces and one curved face, the flat faces being inclined longitudinally so that the segments have both a radial and a

longitudinal sliding movement. Other forms of segments have 2 convex faces or 2 convex and one concave face, the segments preferably interfitting to form a complete cylinder when properly arranged. The housing is formed of 2 sections widening at their connected ends to form a grinding chamber which is fitted with a cylindrical steel liner and removable conical liners. The cylindrical parts of the sections are fitted respectively with spiral ribs or flanges running in opposite directions, the ribs being arranged to feed backwardly into the chamber any large fragments of the material under treatment. A draft of air or steam is maintained through the housing and an outlet pipe, whereby dust may be separated from the granular product and carried away through the pipe, while the ground material falls through a discharge opening. Rotation of the housing is effected by an external wheel gearing with a pinion on a long shaft, which is driven by a pulley and is fitted with a second pulley for rotating a further shaft disposed in a feed trough. In a modification the housing is formed in 3 sections, the center one being cylindrical, and is fitted with 2 rollers separated by a disk of steel or like material.

Art

Coöperation between artists and manufacturers. E. DE F. CURTIS. *Bull. Amer. Ceram. Soc.*, **7** [6], 163–65(1928).—A study was made of the methods employed in other industries in their efforts to obtain suitably trained designers. This kind of survey was made in 1922 and the results were published under the title "Art in Industry." Several conclusions drawn from a study of this book and from discussions of the question with architects, school principals, building construction superintendents, museum directors, retail dealers, and industrial art directors are listed and then summed up into three steps: (1) the need by the factory, (2) the production of the designer, (3) the acceptance of the responsibility by the factory. Other industries are stressing the quality of design in their products which is a challenge to the ceramic industry to do something in that line. E.J.V.

America demanding art in industry. ANON. *Glass Ind.*, **9** [6], 131–33(1928); *Ceram. Ind.*, **10** [6], 608–09(1928); *Ceram. Age*, **11** [5] 163–73(1928).—A report of the international exposition of foreign and domestic-made artistic products, including glass, held in the department store of R. H. Macy & Co. in New York, May 1928. The addresses given by Percy S. Straus, vice-president of R. H. Macy & Co. and Robert W. de Forest, president of the Metropolitan Museum of Art, on the opening day of the exposition are briefly abstracted. E.J.V.

Technique of old Delft faience. ANON. *Keramos*, **7** [5], T 5(1928).—The methods and equipment used in manufacture of faience in the 17th and 18th Centuries are described. The body and glaze compositions used in these periods are given. F.P.H.

Concrete made with colored glass. ANON. *Glass*, **4** [10], 441(1927).—A new method of producing colored concrete, by mixing colored glass with the cement, has been developed and is offered as a means of eliminating the drab appearance of buildings and highways in towns and cities. An unlimited variety of patterns and color effects is obtainable, and it is claimed that the tints will not fade. A.J.M.

Ceramics and glass in ancient Egypt. ANON. *Keram. Rund.*, **36**, 170–73(1928).—The characteristics of the ceramic art of ancient Egypt are discussed and photographs of pottery and faience are shown. H.I.

Stained glass. A. D. *Creative Art*, **2** [5], 357–58(1928).—F. X. Zettler revived the art of glass painting and his work is now being carried on by his two sons who have benefited by his research work in ancient forged glass. The window in the Liebfaunkirche, Worms, is mentioned as a most unusual piece of work. M.G.W.

Faience of Vienna. A. S. L. *Creative Art*, **2** [5], 367 (1928).—Revival of Viennese pottery due to Michel Powolny. Dina Kuhn and Hertha Pucher have gained reputation for excellent craftsmanship and feeling, knowing the limitation of the medium. Faience is designed by them and executed by the factory of Friedrich Goldscheider. M.G.W.

Recent accessions of Athenian vases. GISELA M. A. RICHTER. *Bull. Met. Mus. of Art*, **23** [4], 107–12 (1928).—Newly acquired Athenian vases are shown in the Room of Recent Accessions. Most of the red-figured examples can be attributed to well-known vase painters. Several of these painters have not been represented in our collection up to this time. The vases range in date from 500–475 B.C. to the latter part of the 5th Century. A.A.A.

The new appreciation of Meissen. CELIA WOODWARD. *Int. Studio*, **90** [373], 17–20 (1928).—Dresden porcelain has recovered from the old disfavor into which it had fallen and has recently brought higher prices than Chelsea. The production of porcelain, like the Chinese ware, was achieved by Böttger, who was being held by Augustus II of Poland and Saxony in an attempt to force him to produce gold by alchemy. The manufacture of porcelain was substituted and became popular. The porcelain was so hard that it could be cut and polished on a lapidary's wheel. Böttger was succeeded by Herold, who with his modeler, Kandler, is responsible for the fame of the Meissen factory. The advent of Acier, a French artist, about 1765, introduced into the ware the cheap sentimentality of the period and is responsible for lace trimmed dresses, still turned out by the factory for the artless minded and naïve. The best period ended in 1765. E.B.H.

Tuscan majolica in the Schiff collection. ALFRED M. FRANKFURTER. *Int. Studio*, **90** [373], 47–55 (1928).—Of very ancient paternity, pottery began its new life in the fertile quattrocento very primitively. Majolica, or pottery with a certain opaque glaze made with oxide of tin, may have existed in Roman times but there was no production of it in Italy during the first 14 centuries, A.D. From the island of Majorca the secrets of stanniferous glaze were carried to Italy. M. Schiff of New York has assembled a splendid collection embracing examples of earliest primitive to high Renaissance style, 1400 to 1530. It contains examples from Florence, Orvieto, Siena, Deruta, Faenza, Gubbio, Urbino, Tuscany, Lombardy, Northern Italy, and Venice and may be divided into 4 categories: (1) Primitive or Romanesque 1390–1410, (2) Oriental or Oriental Spanish 1400–1470, (3) Gothic Renaissance 1470–1500, (4) High Renaissance after 1500. Many pieces are described and illustrated in the article. E.B.H.

Mosaic floors in ancient Greece. C. T. SELTMAN. *Illust. London News*, **172**, 948–49 (1928).—New discoveries at Olynthus by the Johns Hopkins Expedition under D. M. Robinson have filled a gap in our knowledge of the great classical age of the 5th and 4th Centuries B.C. The site of the city has been undisturbed since its destruction by Philip of Macedon. Photographs show marble bathrooms and mosaic floors, a vase in the shape of an Ethiopian head, and a mold for making terra cotta figures of the goddess Cybele. H.H.S.

Colorimetric studies with an improved Stammer colorimeter. K. ZERT. *Z. Zuckerind Czechoslav. Rept.*, **52**, 57–63 (1927).—After a short historical review Z. cites the principal causes leading to errors in color measurements with the Stammer instrument. Measurements of the color intensity of standard color plates of various makes revealed great discrepancies in their color values. By replacing the standard color plates with a 0.1% solution of $K_2Cr_2O_7$ which is pure yellow, and producing a reddish shade by the interposition of a red glass wedge, and a grayish shade by decreasing the light intensity with an adjustable screen, a number of observers succeeded in obtaining closely agreeing results in daylight or with daylight lamps. (*C.A.*)

Cement, Lime, and Plaster

Testing Portland cements. M. DUGORDIN. *Le Ciment*, March, 1928; *Rock Prod.*, **31** [10], 104 (1928).—D. reviews the improvements made in the manufacture of cement and the design of concrete mixes. The testing of Portland cement has not kept pace with either of these and the work of certain laboratories of high standing is reviewed to show the wide differences found in such testing. Graphs and tables show that differences as great as 47% may be found. A table shows the result of nationality in the testing of cements. Two samples tested in eight countries showed variations of 81 to 125% of the French test. D. draws the conclusions that if laboratory men working with the thermometer and balance, using a determined and calibrated sand, have difficulty in making their tests agree, it is not surprising to find discrepancies in every day testing. The results should be examined with care before drawing conclusions to take account of the following points: (1) Each test should include the breaking of several test pieces of the same mortar to provide an average so that an abnormal test piece may be eliminated. (2) Frequent checks should be made, especially on those results obtained for the longer periods; guard against drawing conclusions after 28 or 90 days from a single test that cannot be easily repeated, if the results appear doubtful. (3) Make at the same time the following laboratory tests: (*a*) on cement alone in normal mortar following the standard strength test (these tests give comparable results and are the only ones which permit the builder to judge of the product furnished); (*b*) on the concrete prepared in the laboratory with the materials and proportions of the field mix. The strength of these tests compared with the strengths obtained from test pieces made in the field work permit the engineer to judge of the field method and to know whether or not he is getting the best results from the cement. A well-made concrete with a water-cement ratio of 0.53 should give strengths of the order of 66% of the 1:3 normal mortar. (4) In comparing cements of different brands tests should be made under identical conditions, whether in the field or laboratory, *i.e.*, with the same proportions, aggregates, and operators. F.P.H.

Lime burning practice based on European and American observation. IV. VICTOR J. AZBE. *Rock Prod.*, **31** [10], 60–63 (1928).—The mixed feed kilns of Dumont-Wautier at Hermalle-Sons-Huy in Belgium near Liege are described. For preceding abstracts see *Ceram. Abs.*, **7** [7], 427 (1928). F.P.H.

Literature on setting and hardening processes in Portland cement. R. H. BOGUE. *Rock Prod.*, **31** [10], 69–70 (1928).—The early views on this subject are summarized as follows: The scientific examination of the hydraulic cementing materials was introduced by the studies of Smeaton in 1756. S. discovered that the presence of clay in the limestone was necessary to the production of hydraulic material, but he could not account for this action. Bergman thought that a manganese compound in the clay was responsible for the hydraulic properties, but this was disproved by Vitalis and others who showed that good cements could be made from clays free of manganese. Vicat demonstrated the necessity of silica and alumina in the clay, and accounted for the hardening of such cements by the theory of a chemical affinity of the lime, silica, and alumina for water and for each other. Fuchs rejected the hydration theory of Vicat and introduced the hypothesis that hardening is due to a combination of the free lime with "soluble silica." On the discovery of the true Portland cements there followed much controversy on the presence or absence of free lime in the product. Chatoney and Rivot in 1856 revived and extended Vicat's theory. They contended that the setting and hardening were due to the hydration of definite silicates and aluminates of lime and of more complex double salts of three or more components. Fremy, however, insisted that only the aluminates were of value as hydraulic constituents of cements, but Landrin demonstrated that the aluminates were more soluble than the silicates. Hence

structures made with them would not be desirable. This represents the situation on the theory of the processes of setting and hardening of cements up to the period of LeChatelier. F.P.H.

Technology of gypsum plaster materials. III. OTTO FR. HONUS. *Rock Prod.*, **31** [10], 72–73 (1928).—This article deals with the atomic structure of gypsum, anhydrite, and calcined gypsum. The hydration of gypsum phases is described. For preceding abstracts see *Ceram. Abs.*, **7** [7], 427 (1928). F.P.H.

New developments in cement manufacture. EDMUND SHAW. *Rock Prod.*, **31** [10], 79–80 (1928).—Some minor problems of the industry are discussed. F.P.H.

Iron oxide vs. alumina as a fluxing agent in the manufacture of Portland cement. ALTON J. BLANK. *Rock Prod.*, **31** [11], 48–49 (1928).—With too high an iron oxide content in the cement there remains the possiblity of ring trouble and balling up of the material in the kiln. The advantages of increasing the iron content in the raw materials, and thereby displacing a part of the alumina content, have been beneficial in promoting excellent fuel economy, and have increased the quality of the cement to a marked degree. This iron ore, though an expensive raw material, had only to establish a fuel oil savings of 0.28 part of a gallon of fuel oil per barrel of clinker burned in order to pay for itself. To date it is not only paying for itself in the saving of 0.28 part of a gallon of fuel oil per barrel of clinker burned, but is effecting a further savings approximating 1.22 gal. per barrel. In cement plants where cheap fuel is obtainable in the form of coal, gas, or oil this savings in kiln fuel is no great item, yet the better quality cement obtained by displacement of a part of the alumina content with iron oxide, is worthy of consideration. In cement plants situated at a distance from their fuel supply and where the fuel item alone approximates $^1/_6$ to $^1/_3$ the total cost of manufacture, this fuel saving is alone an item of necessity. Where continued trouble is experienced in cement plants with the unsoundess and low strength factors in their cement, this ability to better the all-around qualities of the cement through the displacement of part of the alumina constituent with iron oxide is a matter worth investigating. F.P.H.

Convention of German cement manufacturers. C. R. PLATZMAN. *Rock Prod.*, **31** [11], 50–51 (1928).—The following papers presented at the annual meeting of the German Portland Cement Assn. are abstracted: (1) "Research on Alite," by E. Janecke, (2) "The Chemistry of High Early Strength Cements," by Hans Kühl, (3) "Cement Investigations," by R. Nacken, (4) "Mortar and Concrete," by E. Probst, (5) "Porous Cement," by J. Meyer, (6) "Steam Curing of Test Samples," by Karl Biehl, (7) "Shrinkage Due to Setting," by E. Schott. F.P.H.

Manufacture of early high strength Portland cement. GEORGE P. DIECKMANN. *Rock Prod.*, **31** [11], 58 (1928).—Particular reference is made to "Novo" cement developed in Germany. The properties of this cement are compared with other cements. A number of factors inseparably influence each other and enter the production of early strength cement, namely: (1) raw materials must have the right composition, *i.e.*, the silicate and hydraulic and alumina and iron ratios must be properly adjusted to each other; (2) raw materials must be so finely ground that all components can react with each other without leaving any particles of the material unaffected; (3) a perfectly uniform clinker, thoroughly burnt, is produced with good fuel; (4) the resulting cement is ground to the desired fineness. F.P.H.

Constituents of Portland cement clinker and of hydration products of hydraulic cements. A. GUTTMAN AND F. GILLE. *Tonind. Ztg.*, **52** [22], 418-21 (1928); *Rock Prod.*, **31** [11], 88–89 (1928).—Guttman, director of the Research Institute of the Iron Portland Cement Industry of Germany, and his associate, Gille, recently published an article on Portland cement clinker and hydration products of hydraulic cement. The paper, in tabular form, is a compilation of their own as well as American results of

investigation in this field. He identifies various mineral constituents of clinker as follows: (1) alite: mixed crystals of mostly $3CaO \cdot SiO_2$ with varying amounts of $3CaO \cdot Al_2O_3$; hexagonal plates; (2) belite: $2CaO \cdot SiO_2$; calcium partially replaced by Fe, Mg, Mn; (3) dicalcium silicate: Ca_2SiO_4; rectangles, rhombs, and hexagons; (4) free lime: CaO; rounded dendrites; (5) celite: considerable Fe_2O_3; (6) calcium aluminate: (*a*) $3CaO \cdot Al_2O_3$, (*b*) $5CaO \cdot 3Al_2O_3$, and (*c*) $3CaO \cdot Al_2O_3$; granular, rarely octahedral; rapid set with strength; $5CaO \cdot Al_2O_3$; most granular, slow set with little strength; crystals of unknown composition; mostly spherical; (7) felit: (dicalcium silicate) Ca_2SiO_4; elongated crystals with clevage planes; (8) glass: large Al_2O_3 content. The following 5 products of hydration were observed: (1) Calcium hydrate: $Ca(OH)_2$; hexagonal prisms; obtained by the hydration of normal and calcium cement. (2) Hydrate of tricalcium aluminate; $3CaO \cdot Al_2O_3\ 5^1/_2H_2O$; $3CaO \cdot Al_2O_3 9H_2O$, $3CaO \cdot Al_2O_3 7H_2O$; plates, needles, and rounded needles; obtained by the hydration of alumina-cement and clinker. (3) Calcium-hydro-silicate: $CaO \cdot SiO_2 \cdot NH_2O$. (4) Calcium sulpho-aluminate: $3CaO \cdot Al_2O_3 3CaSO_4 + 30\text{–}42H_2O$; thin elongated crystals, hexagonal and truncated; obtained by the action of sulphates. (5) Silica gel: obtained from normal set tests of clinker grains. Optical properties of these minerals will be discussed in another article.

F.P.H.

American lime plants. LANGE. *Tonind. Ztg.*, **52** [24], 467 (1928); *Rock Prod.*, **31** [10], 104–105 (1928).—The relation of German and American lime industries is described and observations are given on achievements of the American lime industry in certain respects in which the German industry is yet undeveloped. This applies to gas firing in preference to mixed fuel (or mixed feed) as practiced predominantly in Germany in burning lime and to mechanical manufacture of hydrated lime. The latter has replaced the former for structural and agricultural purposes as well as for use in concrete or road construction. It has been shown that its admixture insures a smoother and more resistant road surface. This lime product, therefore, seems able to claim considerable possibilities in the future which have been realized in the German industry as well. Proceedings of the convention of the Assn. of German Lime Mfgrs., Berlin, March 2. F.P.H.

Heat economy of a uniflow cement kiln. CARL NASKE. *Zement*, **17**, March 8 (1928); *Rock Prod.*, **31** [10], 104 (1928).—N. uses the term "uniflow" to designate a kiln which receives its charge of material and fuel at the same end, so that both traverse the kiln in the same direction. For conditions assumed 34,065 Cal. become wasted in the ordinary kiln as there is no provision for their utilization. To avoid this loss of heat, there remains but one step, *i.e.*, preheating the air by means of a maximum possible amount of excess heat to a degree higher than that possible by means of the clinker heat. This can be carried to a temperature of 800°C, which corresponds to a further preheating of $800-452 = 348$°C. The flue gases would thus be made to give up: $(800-452) \times 0.25 \times 285 = 24{,}795$ Cal. The heat not utilized would then become $34{,}056-24{,}795 = 9261$ Cal. The actual fuel consumption would be reduced to $26.64-(24{,}795 \div 7143) = 23.17$ kg. per 100 kg. clinker. The following heat balance would be obtained: (*a*) input: $23.17 \times 7143 = 165{,}503$ Cal.; exothermic reaction = 11,400 Cal.; total = 176,903 Cal. (*b*) output: dissociation = 49,500 Cal., power = 63,470 Cal., drying = 18,000 Cal., loss = 45,933 Cal., total = 176,903 Cal. The efficiency of this type of kiln would be raised to $(49{,}500+63{,}470+18{,}000) = 176{,}903$ or about 74%, or to $2^1/_2$ times that of a rotary kiln in its primitive condition. This efficiency can only be attained if the following conditions are satisfied: (1) utilization of clinker heat to the extent of about 85% of the available heat, (2) utilization of the heat of flue gases to the same extent (to preheat the air supply to still higher temperatures), (3) utilization of the heat of flue gases for power generation. The most recent types of clinker coolers, designed by Knuettal, Stehman, etc., may utilize the waste heat for preheating the air supply to the extent that not over 15% of

it will be lost. Should the third condition not be fulfilled (in the event the cement plant does not generate its own power but purchases it from other sources), the uniflow rotary kiln becomes uneconomical and every other type of kiln, including the automatic shaft kiln, presents greater advantages, in spite of its good points such as small combustion space, high capacity, low cost of installation, and most desirable concentration of operation. F.P.H.

Unit weight of Portland cement. HAEGERMANN. *Zement*, **17**, March 8 (1928); *Rock Prod.*, **31** [11], 88 (1928).—H. of the research laboratory of the German Assn. of Portland Cement Mfgrs. at Karlshorst has made a study of the methods of determining the weight per unit of Portland cement. He summarizes his investigations as follows: The weight per unit volume of a powdered material is influenced by the size and shape of the container used in the measurements and by the method of filling the container. To obtain results of practical value, the shape of the containers and the method of filling these with a powdered material should be made the subject of exact specifications and the latter given general recognition. The average weight of a hectoliter of Portland cement is as follows: ordinary Portland cement, 126.6 kg.; high strength Portland cement, 120.2 kg. The weight per unit volume of high strength Portland cement is lower than that of ordinary Portland cement due to its greater fineness. The value, 1.4, given formerly as the average unit weight of ordinary cements, applied to weight per cu. m. The weight per cu. m. divided by 10 or 1000 does not give the hectoliter or the liter weight, nor can the weight per cu. m. be computed from the latter by multiplication; neither does multiplying the liter weight by 100 yield the correct hectoliter weight. The use of empirically determined computing factors leads to considerable variations, when the containers are filled by mechanical means (the Böhme apparatus or chute) or by hand and the liter weight determined. It is possible, however, to determine approximately the hectoliter weight from the liter weight when the latter is obtained on material receiving a specified number of shocks upon entering the container. The formula applies: liter weight "shaken" $\times 660 =$ hectoliter weight. It is assumed that standard procedure is followed. The determination of weight per hectoliter from smaller quantities can be done by Goslich's method (*Zement*, **16** [38], 895 (1927); *Ceram. Abs.*, **7** [2], 68 (1928)). G. lets cement drop from the bin into a 2-liter container. The height of drop, however, which can appreciably affect the results, remains to be determined by tests so that multiplying the 2-liter weight by 5 would yield the weight per hectoliter. This method has the advantage of time saving and freedom from errors due to the personal equation. F.P.H.

Preventing excessive wear in mills for crushing and grinding. B. E. FIELD. *Chem. Met. Eng.*, **35**, 96–98 (1928).—Increased life and production have been obtained in the cement industry by applying a thin coating of Stellite to the wearing surfaces. The Stellite is sold as welding rod, and is welded to the steel parts by ordinary welding methods. A test made in one plant on two mills working side by side on the same material showed that a Stellited ring has outlasted 9 steel rings, and is still in service. M.E.M.

Influence of water on the strength of powdered materials after heating. BERNWARD GARRE. *Keram. Rund.*, **36**, 181–82 (1928); *Tonind. Ztg.*, **52** [13], 229–30 (1928).—Powdered materials after mixing with known amounts of water were made into pellets and consolidated in a press. For comparison the same materials were mixed with benzol instead of water. In general, fine-grained materials such as precipitated Al_2O_3 and SiO_2 when heated to approximately 900°C showed marked increases in strength after mixing with water, the strength increasing with increased amounts (up to 20 or 30%) of water. $CaCO_3$ with the same treatment showed marked increases in strength. Precipitated Al_2O_3, melted and powdered, showed little increase in strength with added

water. Mixing with water increases the strength of water insoluble materials heated to below the recrystallization temperatures due to (1) the action of the water on the grain surfaces and (2) the increased mixing of grains of different sizes and the consequent closer packing. H.I.

Measurement of time of set of calcined gypsum. ANON. Bur. Stand., *Tech. News Bull.*, No. 133, pp. 69–70 (1928).—Vicat needle test commonly used for measuring this property was found not to be of the degree of sensitivity desired, besides which it results in an empirical value giving no indication of length of time over which the reaction between calcium sulphate hemihydrate and water to form gypsum takes place. Tests should be made measuring rise of temperature under adiabatic conditions. Under ideal adiabatic conditions the temperature of a setting mass would rise to a maximum which would be maintained indefinitely. Samples for tests in this work were as follows: Nos. 1 and 2, 25 g. calcium sulphate hemihydrate and 25 ml. water. No. 1 was placed in a paraffine cup and No. 2 in a pint thermos bottle. Sample 3 consisted of 300 g. hemihydrate and 300 ml. water and was placed in paraffined cup. Samples 1, 2, and 3 reached maximum temperature after 26, 26½, and 38 minutes respectively. Adiabatic conditions were not realized in samples 1 and 2 as their cooling curves indicated. Sample 3 because of greater volume gave better results and it is believed under such procedure this method could be used as a measure of time of set. R.A.H.

Cement and chemicals. MOND. *Chem. and Ind.*, **47**, 589 (1928).—The Casebourne Cement Co., whose plant is adjacent to the ammonia factory of Imperial Chemical Industries at Billingham, has been acquired by the latter company with a view to tying in the two industries. Part of the by-produce of the ammonia plant is a precipitated chalk which is suitable for the manufacture of cement, and a new process has been worked out which makes cement and sulphuric acid at the same time. H.H.S.

Use of plaster of Paris as an impression material. W. H. SODEAU AND C. S. GIBSON. *Brit. Dental Jour.*, **1927** (reprint), 27 pp. (1927).—While dental plaster consists mainly of the hemihydrate, the material is a complex and variable mixture and the authors' conclusions are limited to certain types actually examined. The expansion on setting is about 0.3%, but is increased up to 1% by stirring after the mixture has appreciably stiffened or by addition of previously hydrated plaster. Expansion can, however, be reduced to a negligible amount by the use of a K salt as an accelerator, an alkaline substance such as borax being employed if necessary to prevent too rapid setting. The chloride, nitrate, or sulphate of K may be employed, the last in conjunction with borax being very suitable; it is convenient to add an appropriate dyestuff, such as Alizarin S. Data are given of tensile strengths developed by various mixtures under different conditions. (*C. A.*)

Wood cements. P. MARTELL. *Kunstoffe*, **18**, 58–60 (1928).—Directions for making and applying numerous cements, fillers, caulking compounds, etc., for wood for various purposes. (*C. A.*)

PATENTS

Finishing lime and process of making it. ERNEST O. SCHNELL. U. S. 1,670,425. May 22, 1928. The method of making a high plastic finishing lime which comprises burning the limestone, hydrating the powdered limestone with an emulsion of colloidal clay and earth in water, and adding to the fresh hydrated lime when cooled an amount of a dry mixture of colloidal clay and earth.

Manufacturing pipes from asbestos cement. CARL HERZOG. U. S. 1,670,855, May 22, 1928. A method of manufacturing pipes from asbestos cement which comprises the winding up of at least one slab of asbestos cement while still plastic on a mandrel, wrapping a flexible cover on the pipe, and subjecting the pipe to pressure.

Dental cement. NORMAN E. EBERLY. U. S. 1,671,104, May 29, 1928. (1) A den-

tal cement powder comprising a physical mixture of separately produced cement powders, the powder being capable of setting and hardening at room temperature when combined with a phosphoric acid solution to produce a translucent cement, one of the powders being present in the proportion of 70 to 98% and comprising a finely ground basic glass containing silicon and aluminum oxides fused together, and the other cement powder comprising finely ground calcined basic oxides in the proportion of 30 to 2%. (2) A dental cement powder adapted to react with phosphoric acid solution to set and harden at room temperature to form a translucent cement, comprising a calcined physical mixture of finely ground silicon and aluminum oxides which have been fused together, with finely ground calcined basic oxides.

Magnesitic artificial stone. RICHARD HOLLIS ALLISON. U. S. 1,672,293, June 5, 1928. A magnesitic artificial stone formed of Portland cement, calcined American magnesite, pulverized alum, and silica mixed in dry form and having added a liquid containing water, magnesium chloride and sulphuric acid, and a pigment-carrying material.

Cements, furnaces, granulating. O. LELLEP. Brit. 288,192, May 31, 1928. In calcining cement (or burning lime) the pulverized raw material is granulated without addition of fuel and the granules are sintered to clinker in a rotary kiln after preliminary heating by the waste gases from the kiln. Water supplied by a perforated pipe effects granulation in a rotary drum to which the pulverized material is supplied. Annular ribs within the first section of the drum keep the material sufficiently stirred to insure adequate contact with the drops of sprinkled water. Any dust which may escape granulation is separated by sieves and returned to the feed end. For limestone the granulating drum is unnecessary. The granules are fed on to a traveling grate, through which the hot waste gases are passed either under pressure or by the suction of a fan, and after this treatment fall, partly clinkered, down an incline into the relatively short rotary kiln where the treatment is completed.

Artificial-stone compositions. G. CONOD AND F. C. F. LECOULTRE. Brit. 288,202, May 31, 1928. Crystalline calcium carbonate powder (30 kg.) is mixed with calcium sulphate or other binding agent (50 kg.) and with colloidal silica solution (5 kg.) to produce an imitation marble or other stone, which may be veined in known manner. The crystalline $CaCO_3$ may be obtained by baking limestone fragments at 1290°C in an electric oven under 100 atmospheres pressure and disintegrating the hot mass by immersion in water; or by dissolving $CaCO_3$ in water saturated with CO_2 and reprecipitating by Na_2CO_3. The colloidal silica is obtained by dialysis of a mixture of sodium silicate and HCl solutions.

Lining pipes. B. TALBOT. Brit. 288,408, May 31, 1928. Metal pipes, etc., lined centrifugally with cement, concrete, and bitumen, with or without an admixture of slag, rock, and lime, have the lining secured to the tube body by a row of keys such as headed pins integral with or secured to the inside of the metal body or, as shown, of rings of expanded metal.

Enamels

More capacity gained through rearrangement of plant. ANON. *Ceram. Ind.*, **10** [6], 620–21 (1928).—Improvements made by the Karr Stove and Range Co. of Belleville, Ill., are shown which gave the plant more than 20% increase in the dipping department, raised its firing capacity about 30%, and increased its drying capacity 35%.

F.P.H.

Manufacturing enameled metal dials. H. R. WHITTIER. *Ceram. Ind.*, **10** [6], 621–22 (1928).—A description is given of the plant and the processes used at the H. R. Whittier Co., Pequabuck, Conn. An ingenious process is used in making the black dials.

When the dials are ready for the enamel they are placed in a covered booth which is so arranged that the powdered enamel is blown into the booth and only the finest particles fall upon the metal disks. When enough has been deposited suction removes any powder still in the air and the ware is then removed. The printing is done by the simple offset method from line cuts or hand engravings and positive intaglio. Great care must be exercised in the printing operation. This is a rather slow method and production for a single operation does not exceed 1800 plates a day, as it is all hand work. Different color schemes are worked out by use of different dyes. As many colors can be applied as necessary; usually there are not more than two or three. For round printing special machines are used which will print completely around the circle or on curved or irregular surfaces. This is accomplished by means of the use of the offset printing method. Iron dials are prepared for enameling in the usual way and before the finish coat is applied the metal receives a grip or slush coat enamel. The dry enamel is applied over this the same as the copper except that no backing is required. The backs are left plain. Some trouble has been caused by enameling both sides of an article. In enameling both sides there is a tendency for bubbles to appear on the surface. F.P.H.

The semirotary principle for continuous enameling furnaces. H. L. BROOKS. *Enamelist*, **5** [6], 9–11 (1928).—A description of the Manion semirotary furnace having 130 ft. of chain in the furnace at one time, is 7 ft. high, 8 ft. wide and has a surface area of 1918 sq. ft. Fuel consumption, producing 3000 sq. ft. of ware per hr., 20 and 18 gage, is 25½ gal. M.E.M.

Mill additions and color matching. J. E. HANSEN. *Enamelist*, **5** [6], 19–21 (1928).—A discussion of amounts of oxides and precautions necessary in obtaining colored enamels. Browns and reds require more oxide addition to the frit than blues, grays, greens. Red and yellow should be made in leadless frits. Undercharging a mill will affect the color of the resultant enamel. M.E.M.

Theory and practice of pickling. P. V. BLACKBURN. *Enamelist*, **5** [7], 19–20 (1928).—A review of general methods. M.E.M.

Comparison of enameled ware of Russian and non-Russian origin. J. J. SILVESTROWITSCH AND P. N. GRIGORJEW. *Keram. Rund.*, **36**, 187–89 (1928).—Comparative tests were made on Russian and non-Russian cast-iron and sheet-metal enameled ware. Tests included determination of color, resistance to solution in boiling water, acetic acid and soda, resistance to mechanical shock and resistance to quenching after heating to 200°C. Non-Russian enameled ware tested was of Polish, Czechoslovakian and German origin. General results of tests were (1) Russian ware was slightly darker in color than non-Russian; (2) no other marked differences in appearance were noted; (3) Russian ware showed far greater resistance to solution and failure in 1% acetic acid; (4) non-Russian ware showed somewhat greater resistance to quenching after heating; and (5) Russian ware was somewhat superior to non-Russian in resistance to mechanical shock. H.I.

Heat in the application of modern metal finishes. F. W. MANKER. *Ceram. Age*, **11** [5], 178–80 (1928).—M. gives a description of the Milwaukee plant of the Fuller-Warren Co., manufacturers of cooking and heating appliances. The plant consists of an iron foundry, core room, cleaning room, polishing room, machine shop, and two sheet metal departments. Detailed descriptions are given of the japanning ovens and the assembly by continuous line production. In a new enamel plant, built to meet the growing demand for enamel finish ranges, purchased frit is ground in pebble mills. Both spraying and dipping methods are used for application. Four muffle furnaces working on the surface combustion principle are used for firing the enamels. Cast-iron products are sprayed with 3 coats and heated to 1300°F for 12 to 20 min. The steel ground coat is dipped and heated to 1600°F while two white coats are sprayed and then

subjected to a temperature of 1550°F for $2^1/_2$ to 5 min. for each coat. Waste heat is used for drying. A.E.R.W.

Light-colored first-coat enamels for sheet iron. ANON. Bur. Stand., *Tech. News Bull.*, No. 133, p. 71 (1928).—Adhesiveness of enamels to metals was increased by combining treatments of a thin coating of oxide forming in the furnace and the application of different cobalt compounds directly to the metal. Best results were obtained in the application of the cobalt salts when the metal was dipped in a hot solution and allowed to remain there until it reached approximately the temperature of the bath. Cobalt nitrate appeared to be the most desirable salt to use. A description of the treatment given the metal during the application of the salt is included. R.A.H.

Antimony enamels. K. BECK AND W. A. SCHMIDT. *Z. Unters. Lebensm.*, **55**, 1–24 (1928).—The use of antimony compounds, especially sodium metantimonate (Leukonin), in the enamel industry is discussed. The solubility of antimony from the frit and from the enamel of cooking ware in 3% tartaric acid solution was measured, a process for the accurate determination of small quantities of mixed ter- and quinque-valent antimony being used. For enameled ware the method is as follows: 200 cc. of 3% tartaric acid solution are added for each 1 liter volume of the vessel, the latter is covered with a round-bottom flask filled with cold water, and the liquid boiled for $^1/_2$ hr. over a free flame with frequent shaking. After cooling, the solution is diluted to 200 cc. To 50 cc. are added 20 cc. of hydrochloric acid (*d* 1.126) and 1 drop of methyl-orange solution (1 in 500), and the solution is titrated with .001 *N*-potassium bromate solution till colorless. The titration, less a blank, multiplied by 0.0609 gives the tervalent antimony in mg. per 50 cc. For the total antimony the solution (50 cc.) is mixed with 20 cc. of hydrochloric acid (*d* 1.126) (or the solution already titrated may be employed) and heated nearly to boiling. After removal of the flame 10 drops of 10% phospho-tungstic acid are added, followed by sufficient approximately 0.1 *N*-titanous chloride solution to give a cobalt-blue color persisting for 2 min. After 3 min. 2 drops of 0.01% copper sulphate solution are added, and the solution should then be colorless. After a further 5 min. 1 drop of methyl-orange solution is added and the red-colored solution titrated till colorless with 0.001 *N*-potassium bromate. The titration, less a blank, multiplied by 0.0609 gives the total antimony in mg. per 50 cc. (*B. C. A.*)

PATENTS

Spraying device. GEORGE T. PEARSONS. U. S. 1,671,779, May 29, 1928. The combination of a liquid-carrying container, means to place the liquid in the container under compression including a compression chamber into which the liquid is discharged from the container, outlet means in communication with the chamber of the compression provided with openings adapted to register with the openings in the top, means normally holding the closure in closed position, the closure being provided with means projecting through the inlet opening whereby the closure may be opened by a finger of the hand grasping the handle.

Color composition for vitreous enamel. HAROLD V. HUBER AND THOMAS M. FELTON. U. S. 1,673,679, June 12, 1928. A vitrifiable coloring composition including a coloring sulphide, a compound of lead, and another compound having the same base as the sulphide which prevents the formation of a discoloring compound.

Pickling metals. J. H. GRAVELL. Brit. 287,911, May 23, 1928. In the process of pickling metals in which to prevent the action of the acid on the cleansed metal a foam-producing agent such as saponin, rye-meal liquor or cellulose pulp waste is added to the bath, formaldehyde, paraformaldehyde, or materials such as thioamides or substituted thioamides such as thiocarbanilide capable of generating formaldehyde in an acid bath in the presence of a metal are added to the bath to protect the foam formed.

A mixture of cellulose pulp waste liquor and thiocarbanilide is added to an acid bath containing sulphuric acid.

Pickling metals. J. H. GRAVELL AND A. DOUTY. Brit. 287,912, May 23, 1928. An inhibiting agent is produced in an acid pickling bath by adding a substance which will combine with the nascent hydrogen, produced by the pickling, to form such an agent which then prevents the acid attacking the cleaned metal. A thiocyanate such as ammonium thiocyanate is added in small quantities to the bath and this reacts with the nascent hydrogen formed to produce hydrocyanic acid which acts as the inhibiting agent. A foaming agent such as cellulose pulp waste liquor may also be added to the bath or the foaming agent and the thiocyanate may be mixed before addition to the bath. The acid used in the bath may comprise sulphuric, hydrochloric, or phosphoric acids.

Glass

Beryllium glass. CHI-FANG LAI AND ALEXANDER SILVERMAN. *Jour. Amer. Ceram. Soc.*, **11** [7], 535–41 (1928). Beryllium glass has been prepared for the first time, and some of its physical and optical properties have been determined. More than eighty different compositions have been melted and studied. Four series were taken from the clear glass area and examined for density, hardness, refractive index, and ultra-violet light transmission in comparison with magnesium and calcium glasses.

The flow of glass in tanks. D. J. MCSWINEY. *Glass*, **4** [8], 330–32 (1927).—For abstract see *Ceram. Abs.*, **6** [10], 433 (1927). A.J.M.

Production of quartz optical flats. ANON. *Glass*, **4** [8], 328 (1927).—These surfaces have been ground and polished so flat that measurements fail to show any places where they are more than two ten-millionths of an inch from being absolutely flat. The disks are 10 to 11 inches in diameter and $1^1/_2$ inches thick. Vitreous silica is used because it has properties which make it superior to optical glass for many purposes. It is harder, and its coefficient of expansion is lower. The surface of glass, formerly used for optical flats, changes considerably in shape when touched by the hand, but clear vitreous silica, with a coefficient of expansion only $^1/_{15}$ that of glass, is not affected much. The low coefficient of expansion of fused silica also recommends its use for astronomical mirrors and for the manufacture of standards of length. In addition to serving as a test for flatness of surfaces and straightness of edges, these standards are used in the production of standard angles and for calibrating or checking instruments for the measurement of curvature. A standard plane should not vary from flatness by more than one ten-millionth of an inch and the temperature distortions of glass during testing cause irregularities greater than the desired degree of precision will permit. In the case of a glass disk the tested and testing surfaces must be left in contact for several hours before they have recovered from the surface warps caused by slight handling or by temperature changes. Clear fused silica, with its lower coefficient of expansion, is affected by temperature changes to a much less degree. The slabs of clear fused quartz were first rough ground in the optical shops. After the rough grinding, all of the work was done by hand on a circular pedestal by swinging the 13-pound disks in ever-changing loops and turns over a grinding or polishing table. Coarse silicon-carbide powder was used at first; a finer powder was used in the later stages. Three disks were ground against each other until a straight-edge failed to show any inaccuracies. All bubbles were reamed out because the sharp edges of such cavities would cause scratches during the polishing process. Finely powdered rouge was the abrasive used during polishing. The rouge was stirred in water and the heavier particles allowed to settle. Uniformly fine rouge was obtained by dipping a brush into the tank. For polishing, a cast-iron plate, 9 inches in diameter,

with a checkered arrangement of V-furrows and covered with a layer of pitch $^3/_8$ inch in thickness, was used. The pitch had to be kept at a certain hardness since there was a tendency for it to heat up due to friction. The operator had to judge properly the length of stroke as well as the type of stroke. At times pressure in addition to the weight of the disk itself was required. There were times when it was necessary to stop the polishing until both the quartz and the pitch had returned to normal temperature. Both sides of the 3 disks were first given a high-grade polish but no tests were made for flatness. One face of each disk was then polished so that it was as near a true plane as could be indicated with the ordinary glass standard of reference. The test for flatness was made by bringing the two surfaces together and observing the interference bands formed by monochromatic light. When viewed perpendicularly these interference bands are straight lines if the surfaces fit, whether plane or curved. If 3 surfaces brought together in pairs fit, they are plane; this is why the 3 surfaces are necessary. An extremely sensitive test for flatness is afforded by noting the straightness of the interference bands when one of the plates is known to be flat. During the third polishing stage a Pulfrich interferometer was used in order to obtain a perpendicular vision over the entire surface. A.J.M.

Plate glass processes. ANON. *Glass*, **4** [8], 339(1927).—The information in this article was obtained during the second hearing on plate glass production costs by the U. S. Tariff Commission. There was considerable divergence of opinion among witnesses as to whether the continuous process was still in the experimental stage or whether it was fully developed. The continuous method of grinding and polishing reduces the cost of these processes by 25%. Continuous flow from a tank results in a somewhat similar reduction in cost of that part of the manufacturing process. A combination of continuous casting and continuous grinding and polishing effects a saving of at least 35–40% on the cost of the old methods. There is a slight difference in the appearance of the glass produced by the two processes; with the continuous method the bubbles are slightly elongated. The fully continuous process is the most modern, the Bicheroux being next as it is only suitable for smaller factories. The Standard Plate Glass Co. has investigated very thoroughly the continuous process and has arrived at the conclusion that when considered from the point of view of making plate glass for general commercial purposes, the process is impracticable; they have decided not to make further investigation as it shows no economy in production costs under the conditions just mentioned. The Edward Ford Plate Glass Co. investigated the process of the Ford Motor Co. and was also convinced that the process is not suitable for general commercial purposes; they have, therefore, made a contract through the St. Gobain Co. for the Bicheroux patents. Pilkington Bros. had installed and were operating the Ford continuous process but are now thoroughly convinced that for general commercial purposes it is not an economical and practical method of making rough plate glass to be afterwards ground and polished. They are now investigating the Bicheroux method. The widest sheet being made by the continuous method is 72 inches, all attempts to produce wider having been abandoned. A.J.M.

Medieval processes of glass manufacture. J. A. KNOWLES. *Glass*, **4** [8], 343 (1927).—Laws were passed in the 12th Century prohibiting the setting up of glass works near towns and cities in order to prevent the increasing cost of wood and because of the danger of fires. According to Plutarch, the ancients used tamarisk wood for their glass furnaces but medieval glass workers used beech wood, which probably yielded a clearer and hotter fire than other kinds. In 1580 it was stated that a beech tree of 1 ft. square "at the stubbe" would make $1^1/_2$ loads of charcoal and that the iron works of Monkswood near Tintern would require 600 such trees every year. As late as the first quarter of the 19th Century, at the famous plate glass works of St. Gobain, faggots of beech wood were

used as fuel. These were thrown into the furnaces by men who, stripped of all superfluous clothing, ran around the furnace. In 1615 all patents for glass making were revoked and a new patent for making glass with coal as fuel was issued to a group of men. At this time the use of covered pots was introduced to protect the molten glass from the products of burning coal. With the issue of this patent the use of wood for melting glass was prohibited, and it was made illegal to import glass from abroad. Some difficulty was experienced in obtaining proper clays for the furnaces and pots. Robert Mansell complained that he was unable to obtain proper clay in England and found it necessary to obtain it from France and Germany. Hardiquer mentioned that a good clay was found in France. Cornelius de Lannoy stated in 1565 that he was forced to send to Antwerp and Hassia for clays. The earliest extant description of a glass furnace is given in a manuscript preserved in the British Museum. This description states that the furnace of the glassmakers should have 6 compartments, of which 3 are disposed in stories one above the other. The lower compartment should be deep; in it is the fire; that of the middle story has an opening in front of the central chambers (these last should be equal, disposed on the sides and not in the center, so that the fire may rise toward the central region where the glass is and melt the materials). The upper compartment, which is vaulted, is arranged so as to uniformly roof over the middle story; it is used to cool the vessels after their manufacture. Theophilus described 3 furnaces. One consisted of a large glass working furnace in which the glass was founded and worked off; with this was combined a "calcar" or reverberatory furnace in which the materials were subjected to a preliminary roasting. Another was a spreading furnace in which the cylinders were spread out into a flat sheet. A third type was an annealing furnace. The working furnace was rectangular, 15 x 10 ft., divided, at a distance of $^2/_3$ of its length, into 2 parts by a wall; the larger part contained the glass pots, while the smaller part was the calcar or furnace in which the materials of the glass received a partial vitrification before being put into the pots. At a height of 4 feet from the ground a floor or hearth was made, provided with holes for the glass pots, and 3 central holes, 2 in the glassmaking furnace and one in the calcar, for the escape of the flames and smoke from the furnace beneath. Close above the upper floor the arched top was made so that the heat was reverberated back to the pots in the founding furnace and upon the mixture of sand and alkali placed on the upper floor of the calcar. The pots were made narrower at the base than the top and the edge was turned in so as to form a lip. Opposite the holes in the upper floor in which the pots were placed were the working holes for gathering the metal and introducing the pots and the frit into them. At each end, the fuel, which consisted of well-dried beech logs, was introduced through furnace holes, and the top of the furnace, which was made flat, was provided with a raised ledge all around, so that the blowing irons and other tools could be rested on the top of the furnace without rolling off. The rectangular furnace seems to have been rare and from the 12th to the middle of the 19th Century all the glass furnaces seem to have been circular.

A.J.M.

The breakage of bottles during the pasteurization process. S. ENGLISH. *Glass*, **4** [10], 420–22 (1927).—Much trouble has been experienced in the pasteurization of beer bottles when the glass seemed to be very satisfactory. The pasteurization of milk causes no difficulties. The process adopted for the pasteurization of beer and stout, in general, consists in taking bottles which have been filled and sealed for several days without showing any signs of leakage and immersing them, on trays or carriers, in a tank of cold water, the temperature of which is gradually raised to 130–140°F. After being maintained at the desired temperature for about $1^1/_2$ to 2 hours the tank is slowly cooled to room temperature. The temperature changes are so low in magnitude and so gradual that they would not cause breakage of a badly made bottle. Observations were

made for certain years and it was found that the breakage of pint bottles is 0.3–4.1% while the breakage of quarts is 2.8–64% with most of the breakages greater than 15%. Such figures suggest that the bottles were bad or that some step of the process was at fault. Bottles as bad as the figures show would certainly not be filled and subjected to such a severe process. The pasteurization was carried out carefully. It seemed clear that some other factor or factors was the true explanation. Some of the factors that influence the breakage of bottles during pasteurization are: (1) Leakage of gas or liquid through the cork or seal may prevent even a bad bottle bursting. Such a safety valve, however, is not desired because it is likely to render the beverage lifeless. (2) The strength of the bottle has an important bearing on its liability to fracture. This is influenced by the composition of the glass, various details concerned with the melting, working, and annealing processes, and by the shape and size of the bottles. Pints are much stronger than quarts because (*a*) they have a smaller expanse of glass on which the pressure is exerted, and (*b*) there is no appreciable reduction in the thickness of the walls. (3) The most important factor affecting liability to breakage is the development of an internal pressure to an unknown extent. Some of the factors which control this pressure are (*a*) air space left in the filling operation above the liquid level, (*b*) pressure due to fermentation before pasteurization commenced, (*c*) the solubility at various temperatures of air and other gases produced by fermentation, (*d*) leakage past the sealing cork, and (*e*) the relative expansion with rising temperature of the glass and the contents of the bottle. The first and last are of greatest importance. Water, the main constituent of beverages, has a much greater expansion than glass and a bottle just full of water at room temperature would be more than full at the pasteurizing temperature. If the bottle were sealed an enormous pressure would be developed. Since glass is relatively inelastic the bottle would soon burst. Experiments by E. showed that quart bottles filled to within 2 inches of the top at 65°F had an internal pressure of 1 atmosphere; at 140°F these same bottles were filled to the top and the pressure was infinitely high. Had the bottles been sealed they would have shattered because the mean internal pressure required to fracture quart bottles was found to be 14.8 atmospheres. Experiments were carried out to determine the proper filling level. The results showed that the pressure developed in bottles during pasteurization depends on the initial pressure and on the level to which the bottle is filled. As the filling level is lowered the pressure developed and the risk of breakage is rapidly reduced. E. suggests that a liquid level giving a free air space of 2.5–3.0% should be adopted. A.J.M.

Instruments in glass works. ANON. *Glass*, **4** [10], 423–24 (1927).—When contemplating the purchase of equipment of this nature one of the points to be decided is whether indicating or recording apparatus shall be installed. Recorders can frequently be of greater value than is usually thought, especially in some of the smaller works where the personal supervision during the night shifts is not quite so effective as during the day time. One instance of this is a recording pyrometer on a leer as an examination of the chart the following morning would frequently give immediate indication of the reason for complaints. Another question which often causes trouble is the location of the indicators or recorders. Some prefer the instruments to be in the foreman's or engineer's office. This has the advantage that all can be seen at once and the man in charge can keep in close touch with what is occurring. The disadvantage of this method is that the operator cannot readily see the instruments. This applies particularly to those cases where the operator has means available for making adjustments to counteract changing conditions. *Ibid.*, [11], 472 (1927).—Recorders are more expensive than indicators but in many cases the additional expense is justified. Electrical power finds much use in a glass plant and in order to determine power consumption it is essential that instruments be placed in the mains supplying each department. An integrating

wattmeter is excellent but if the expense of these is too great, much information can be obtained from ammeters placed in the circuits. Since the voltage remains practically constant the power consumption may be estimated very closely. The ammeter is also useful in showing if motors are being overloaded and in giving warnings of troubles in direct driven machines. A.J.M.

Air filters in glass works. ANON. *Glass*, **4** [10], 425 (1927).—In the glass industry every care is taken to keep the ingredients of the metal free from foreign matter which would spoil the appearance and quality of the product. It is therefore essential that precautions be taken to protect the work from extraneous dust during the process of manufacture. Large quantities of air are used for blowing the metal into shape and for cooling the molds. Standard air compressors are used and it is advantageous to filter the air which these machines inhale. Ordinary atmospheric air contains a certain amount of solid impurities such as sand, grit, fiber, etc., commonly referred to as dust, which, when mixed with lubricating oil, has an abrasive effect on the piston rings and cylinder walls. By the use of an effective air filter the dust can be eliminated before reaching the cylinder with the result that less lubricating oil is required, the life of the machine is increased, and dust-free air is supplied by the blowing nozzles. Dustless air should be used for cooling the molds. This air is usually supplied by a fan of the high pressure type and should be equipped with a filter. A new type of all metal air filter is illustrated and described. The filter is made up of cells containing brass rings or ferrules. The complete cell is dipped in an oil of high viscosity and this oil serves as the filter medium. The dirty cells are cleaned in rotation at regular intervals by rinsing them bodily in hot soda water after which they are re-oiled. A.J.M.

Some coloring agents in glasses and glazes. H. JACKSON. *Glass*, **4** [10], 443 (1927); *Nature* **120**, 264 (1927); for abstract see *Ceram. Abs.*, **6** [11], 509 (1927). A.J.M.

Annealing of glass. II. H. V. E. RENN. *Glass*, **4** [11], 470 (1927).—Lower critical temperature is that below which only temporary stresses are acquired by the glass, no matter what rate of cooling is employed. If this is unknown, the glass may be cooled too slowly and time will be lost. If the cooling is too rapid above this temperature viscous yielding will occur and permanent strain will be set up in the glass. The location of the lower critical temperature depends somewhat on the type of glass but it can be calculated if the annealing temperature has been determined from the mathematical formula of Twyman. The lower critical temperature is usually estimated to be 150–300°C below the annealing temperature but these estimates may fall wide of the mark. Both the lower critical temperature and the annealing temperature depend upon the rate of change of mobility of the glass as it is cooled. This is the third important factor governing the annealing process. To measure the change of mobility, a carefully measured strip of glass is clamped in a jig and loaded with a known weight. It is then placed in a tube furnace and readings taken of the rate of deflection at various temperatures. It is thus possible to find for any temperature the rate of increase of permanent strain for any stress, that is the extension of unit length per hour or the compression of unit length per hour according as the stress is tensile or compressive. It was found by Twyman that the mobility doubled for every 8°C rise in temperature. This may be expressed by the formula, $M = k2^{\Theta/8}$, where M is the mobility, k a constant depending on the glass, and Θ the temperature. If a definite stress is relieved in a glass in 3 minutes at 500°C, it will be relieved in 6 minutes at 492°C and in 12 minutes at 484°C. It has been found by other experimenters that the temperature interval in which the rate of release of stress is doubled varies from 8 to 11°C with different glasses, the average being nearer 9°C than 8°C. English has shown that there is a definite tendency for the mobility to become less as the proportion of lime is increased. Twyman's equation, however, is confirmed as a fairly accurate generalization within the ranges of tempera-

ture which are of interest in annealing. The correct cooling procedure is of great importance. English and Turner state that the temperature should be decreased rapidly to the point at which the glass begins to stiffen. The rate of cooling is then decreased until the glass has become so cool as to be rigid. This means that glass should be cooled rapidly from the annealing temperature to the lower critical temperature and the rate of cooling is to be decreased after that. The above method is not in accordance with the theory just given. In cooling rapidly in the annealing range, temporary stresses are set up and partly relieved by viscous yielding. The stresses which are relieved show up as permanent stresses when the glass has reached room temperature. The correct manner of cooling for each type of glass should be determined. The leer is a most important factor in annealing. A leer is required that is capable of such control as to give any desired set of annealing conditions. The Hartford leer fulfills this condition. On these leers an ingenious automatic thermostatic device maintains the desired temperature conditions constant, thus dispensing entirely with the human element. For preceding article see *Ceram. Abs.*, **7** [3], 146 (1928). A.J.M.

Reducing running costs in the glass plant. ANON. *Glass*, **4** [11], 473 (1927).—A detailed discussion with data and calculations is given. The plan outlined is one which utilizes waste steam from the engines to saturate the air entering the gas producers. A.J.M.

Glass furnace construction. A. ALISON. *Glass*, **4** [12], 512 (1927).—A. discusses the raft, flues, regenerators, supporting walls, tank, bridge wall, crown, and combustion chamber. A cross-section of the tank furnace is given. The article shows graphical methods for computing the stresses set up in the buck stays by reason of the thrust of the crown. A diagram shows the effect of expansion of the arch. A monograph shows the relation between volume of combustion chamber, width of tank between walls, and height of wall. A chart showing the relation of gas volume and temperature is also given. *Ibid.*, **5** [1], 4 (1928).—Burners, frictional losses, steelwork, tank bearers, side wall supports, shoulder beams, buckstays are discussed. Charts are given for the velocity of gases through port opening, frictional resistance with gas velocity and flue area, and temperature corrections to be added to gas velocities. Bending moment diagrams for tank bearers and buckstays are included. *Ibid.*, **5** [2], 48 (1928).—The following are discussed: buckstay anchorage, assuming base to be fixed; buckstay anchorage, assuming both ends are free; ties; miscellaneous bracings; chimney; static draft. Detailed calculations are given. The article contains a graph showing the relation between static draft and mean flue gas temperature for a chimney 100 ft. high as well as a chart showing the same relation for chimneys of different heights. *Ibid.*, **5** [3], 96 (1928).—Chimneys, available draft, draft expended in imparting velocity, frictional losses, and resistance due to bends are discussed. Charts are given for (1) variation of air density with barometric conditions; (2) corrected static draft for flue gases of different density; (3) relationship of loss of draft to velocity and temperature of gases; (4) static draft for various air and gas temperatures for chimney 100 ft. high; (5) monograph connecting velocity with draft and temperature; (6) loss of draft from friction per 100 ft. of flue; and (7) chart connecting loss of draft with change in direction of flow of gases. A.J.M.

Design of parison molds. S. ENGLISH. *Glass*, **4** [12], 518 (1927).—Of the three molds, the ring, parison, and blow molds, ordinarily used in the making of bottles by machines, the parison mold is by far the most difficult to design properly. The ring mold and blow mold have a definite shape and size, determined by the bottle it is desired to produce. This is not true of the parison mold. For ideal working, however, both the shape and size of the parison mold are fixed between fairly narrow limits, but neither of them can be obtained directly from measurements of the bottle to be made. The

only feature of parison molds which can be determined even approximately by a study of the bottle is its internal size or glass holding capacity, but even in this respect allowance must be made for the preliminary blow-up which varies from one machine to another and from one type of bottle to another. This glass holding capacity is determined by the weight of the finished bottle. For example, if a parison mold is desired for a quart bottle weighing 24 oz., it is necessary to find the volume of 24 oz. of glass at the temperature at which it is fed into the mold. The volume varies with the nature of the glass and with the temperature. Data by Washburn, Shelton, and Libman give the densities for various glasses at different temperatures. In considering the shape of the parison mold it is found that there is very little information on which to base conclusions. The only feature which is always recognized is the absence of sharp corners either in the mold itself or at its junction with the ring mold. The inner surfaces should always be continuous smooth curves. For narrow neck ware the parison mold used on a hand fed, hand operated machine is comparatively wide and has a flared top. This is necessary in order to permit the easy introduction of gathers of glass which are often of indifferent shape. In turn this wide diameter makes it necessary to use a comparatively short mold, perhaps not much more than half the length of the finished bottle. In the operation of machines fitted with such molds, after inversion, the blank is always allowed to lengthen considerably, and is subjected to a certain amount of manipulation before the blow mold is closed around it and blowing commenced. If this elongation were not permitted, the distribution of the glass would not be satisfactory, as thin-bottomed bottles would be produced, especially if the blowing were carried out quickly. When using machines of the Lynch or O'Neill type, charged by gob feeders, the parison molds are made narrower and correspondingly longer than on hand fed machines. Generally the gob of glass in such a mold rises up the side to a height which corresponds to about $^3/_4$ the height of the finished bottle. The mold is always somewhat longer than this to allow for the preliminary blow-up which brings the length of the blank when inverted to about $^1/_2$ inch less than the full bottle length. When the blank is blown up from its compact condition in the lower portion of the parison mold the hot core of glass from the middle of the blank is blown out and spreads itself over the more or less cooled walls of glass so that when inverted and enclosed within the blow mold there is a ring about three-quarters of the way down at which the temperature of the glass changes from relatively cool to a somewhat higher temperature. During the blowing process the hotter glass stretches and distends more easily than the cooler glass and a variation of wall thickness is produced. If feeding devices were so improved as to deliver narrow but compact gobs of glass this effect would be reduced to a minimum or removed entirely. The parison molds could be reduced in diameter and the height of the compact gob of glass increased. Then the whole of the glass displaced by the preliminary blow-up would come in contact with the walls and the seal over the top of the parison mold and the temperature would become more uniform. Parison molds for suction machines meet this condition because they are about as long as the finished bottle. The molds are relatively narrow in diameter. The whole length of the blank is in contact with the side of the mold from the moment of filling and there is practically no differential cooling and no variation in wall thickness of the finished bottle. From the point of view of parison mold design, suction feeding appears to bring with it two simplifying and advantageous features, namely (1) the total capacity of the mold is easily and definitely determined from the weight of the bottle it is desired to produce and (2) uniform distribution of metal in the finished bottle is not impaired by irregular cooling of the blank. It has been found in practice that a heavy walled mold always keeps cooler than a light walled mold under similar conditions. The tendency during recent years has been to increase the thickness of the walls and a thickness of 3 or $3^1/_2$ inches is not unknown. Some experienced glass engineers prefer to keep the thickness down to

1 inch. The thicker mold requires less external cooling but in case of change of molds it requires a much longer time to heat up. Cast iron with a very fine grain and compact structure is generally used for parison molds. One of the chief troubles that faces some manufacturers of narrow necked bottles is the cracking of crown rings due to chilling of the comparatively thin walls of glass by the metal of the ring mold and plunger. This trouble has been overcome by using stainless steel for these small mold parts. The success of the alloy steel is due to the fact that its coefficient of thermal conductivity is about one-third that of cast iron and cooling is not so rapid. A.J.M.

Output of Canadian glass industry. ANON. *Glass*, **4** [12], 537 (1927).—The glass industry had a production valued at $11,670,269 in 1926 as compared with $10,117,604 in 1925. The seven plants making pressed and blown glass had an output valued at $8,390,035 as compared with $7,444,246 in 1925. In the plate, cut, and ornamental glass industry, 45 plants were in operation, and production in 1926 was valued at $3,280,234 as against $2,673,358 in the previous year. The capital employed in the glass industry in Canada totaled $11,432,823 in 1926 and employment was given to 3033 persons. Capital decreased from $12,694,338 in the previous year but the number of employees rose from 2778 in 1925. A.J.M.

German glass industry. ANON. *Glass*, **4** [12], 537 (1927).—In the following table a comparison is given of 1913 and 1926 exports by classification:

	1913	1925 (Metric tons)	1926
Hollow ware	185,711	97,484	116,332
Mirror and sheet	38,948	37,915	46,160
Optical	1,876	1,626	1,465
Other	4,472	4,342	3,922
Total	231,007	141,367	167,879

In 1926 imports of glass into Germany amounted to nearly 26,000 T. as against 16,600 in 1913, and came from Czechoslovakia, the Saar, Alsace-Lorraine, and Belgium. A.J.M.

Glass tank operation improved by use of preheated air. W. DYRSSEN. *Glass*, **5** [1], 10 (1928); for abstract see *Ceram. Abs.*, **7** [2], 73 (1928). A.J.M.

Machining neck molds for bottles. ANON. *Glass*, **5** [1], 17 (1928).—The machining of a ring mold for bottles is explained in detail. Sketches and illustrations aid greatly in understanding the process. A.J.M.

Cleaning a glass furnace with paving breakers. J. H. WILKINS. *Glass*, **5** [2], 51 (1928).—The furnace on which the test was made measures $21\frac{1}{2}$ x 100 ft. In the bottom of the furnace was a 5-foot mass of unbroken glass containing 398 cubic yds. A 50-pound paving breaker proved too light for the job but an 80-pound breaker was used with success. Moil-pointed steels of 18-inch lengths were found to be best for the purpose because they could bore deeper. By using a point slightly blunter than the standard moil point the steels did not have to be sharpened as often as would otherwise have been the case. Air at 90 lbs. pressure was supplied. Comparison with the hand breaking of 267 cubic yds. of glass showed that the use of paving breakers effected a great saving. The latter method saved about $5.50 on every cubic yard of glass removed; it saved 15.75 man-hours per cubic yd. of glass; the saving on 86 cubic yds. of glass paid for the equipment, power, etc. A.J.M.

Gravity flow process vs. suction feed process. I. B. M. PEARSON. *Ceram. Ind.* **10** [6], 610–18 (1928).—A series of articles will appear on the choice of a glass machine for the glass plant. The advantages and disadvantages of the two processes are enumerated. The data contained in the article were taken from plant log books and daily production charts. In modern glass bottle factories, the bottles are invariably made

by machines. There is, however, a large variety of types of such machines in use and it is necessary to appreciate the principles involved, in order to install the right bottle machines and to spend the available capital to the best advantage. The choice of a bottle machine may depend upon the style of ware being made, the estimated production, peculiarities of production (whether large or small orders will be run upon the machine), the amount of capital available, whether the machines are going into a new or old plant. The machine should be chosen according to the local conditions and these must be very carefully studied before any decision is made. The feature of the suction process is the means for feeding the glass to the machine. The actual means employed is very simple; a vacuum is created in the parison or blank mold by means of a vacuum pump and the molten glass is forced in to fill the mold by the pressure of the atmosphere. The method of effecting contact between the blank mold and the molten glass provided the only real problem which was encountered in the suction process. The solution lay in the revolving pot furnace. With this construction, a circular, shallow, fireclay basin is supported on a column running in a footstep bearing. An auxiliary bearing eliminates vibration of the pot, when rotating. The pot is rotated by an electric motor through gearing. Levelling screws are provided so as to level up the pot when it gets out of true and runs eccentrically. The revolving pot must run absolutely level, as the blank molds would otherwise be dipping into various parts of the pots at different depths of immersion, and in bad cases would not be dipping at times at all. The construction and layout of a revolving pot furnace for serving a suction machine is shown. The pot itself is usually 10 feet in diameter. F.P.H.

Determining gas sources in glass melting. ANON. *Ceram. Ind.*, **10** [6], 618 (1928).—Thus far the development of gas during the melting of a glass that was clear in itself and the clearing of the glass in furnaces was so interpreted, that the gases which are driven off at high temperatures, were in a dissolved condition in the glass. In order to study this process, a few lime-soda glasses were investigated for their gas content at the Institute of Metallurgy at the Technical High School at Aachen, on the basis of the experiences which have been secured in the extraction of gas from metals. For this purpose the apparatus was altered in such a way that a platinum crucible could be heated to about 1400°C in a closed tube. The gases which were extracted through a vacuum of about 1/1000 Hg. were relieved of steam by phosphorous pentoxide, of acid gases (CO_2, SO_2) by cooling with liquefied air, and of O_2 with pure H_2; the balance was expressed as N_2. The increase in pressure after removing the liquid air indicated the volume of acid gases, which could be inspected for SO_2 by the method of ordinary analysis. The melting could be observed directly, so even the smallest development of gas could be followed up. It was shown that in the removal of gas from soda-lime glasses not all of the gases could be removed even under continued heating up to 1400°C; rather an equilibrium was effected at each temperature, which was interrupted at each increase in temperature by a considerable development of gas in order to again effect an equilibrium. From the development of quantities of gases even at 1400°C it could be inferred that this development would stop only at extremely high temperatures. The gases had, according to the temperature at the time being, a one- to two-fold volume of that of the volume of glass from which the gas was removed, and consisted of about $^3/_4$ of CO_2, of O_2, and some N_2 which probably diffused into the apparatus from the air. The hypothesis presented here, that the gases are not in dissolved condition in the glass, but are present only in the nature of chemical combinations, and can be released from them only through thermic disintegration, was supplemented with dissolving experiments on gases in glass, which would prove the insolubility of the gases in the glass. Experiments are being continued on glasses of other compositions and on other silicate melts. F.P.H.

Use of wind system beneath floor of blowing room. ANON. *Ceram. Ind.*, **10** [6], 619–20 (1928).—In the Marion, Ind., plant of the Upland Flint Bottle Co., a wind system is in use. A 6-foot fan, located outside the blowing room, supplies the air through a concrete tunnel. This tunnel is located beneath the floor of the blowing room and extends around the nose of the tank. The dimensions of the tunnel are 6 x 4 feet. Besides cooling the machines, molds, men, and conveyers, the fan supplies sufficient air to cool the tank. This "underground" wind system is one of the many improvements at this plant. F.P.H.

Coloring effects of carbon and its compounds on glass. ANON. *Ceram. Ind.*, **10** [6], 620 (1928).—Carbon or organic compounds produce colors varying from light yellow to dark red on four types of glasses. A dark color was produced in calcium, magnesium, and barium glasses, whereas zinc and lead glasses are very light in color or colorless. Soda glasses are lighter than potash glasses. The alkali content has no effect, the other ingredients remaining unchanged. The color effect of organic compounds decreases with the oxygen content and hydroxyl group, and increases with the carbon content. Arsenious oxide is more vigorous than potassium nitrate in counteracting carbon in glass. F.P.H.

Progress outlined at Glass Container meeting. ANON. *Ceram. Ind.*, **10** [6], 639–40 (1928).—At the annual meeting of the Glass Container Assn. in Atlantic City, April 26–28, A. Silverman of the University of Pittsburgh presented lantern slides outlining the development of processes and products in the glass industry throughout history. The first industrial enterprise on American soil was a glass manufactory established near Jamestown, Va., in 1607. Progress of the industry within the last decade has been so rapid as to equal that of half a century in earlier periods. He predicts the extinction of the "dog house" and the cylinder method of production in the window glass industry. Much opportunity for vital contributions to further progress was furnished by a close study of annealing. F.P.H.

An elementary weathering test for glasses. F. SPATE. *Le Verre*, **7** [1], 1–3 (1927).—The subjection of glasses to an atmosphere of carbon dioxide saturated with water at ordinary room temperatures is proposed as a test of resistance to atmospheric agents. This process produces the ordinary weathering effects but much more quickly. The formation of a liquid film, decomposition by hydrolysis, and the formation of carbonates take place. S. discusses the work of previous investigators, and the principle of the foregoing test. A theory of weathering depending on the formation of a liquid film on the glass is given in detail and experiments cited to prove the main points. The results of tests on seven different glasses are reported. A.E.R.W.

Density control of glass tanks. A. R. PAYNE. *Glass Ind.*, **9** [6], 121–25 (1928).—With instruments to show tank temperatures, draft, etc., it is possible to control melting conditions so that in general uniformity of the product is assured. In case the composition changes, density is a key to the composition and to other physical properties which should be regulated and held constant. With well-melted, well-annealed glass it has been found that (*a*) if density changes, the composition has changed, (*b*) if the composition changes, the density will almost invariably change, (*c*) when glass has been good and the density fairly constant, any sudden change in the density indicates a variation in the glassmaking technique and presages trouble, and (*d*) a day-to-day check on the density of the glass is a good index of the uniformity of the metal. A complete chemical analysis would give the same information but could not be completed in time to be as useful in finding the trouble and adopting remedial measures. For every kind of glass there are different proportions of the glassmaking oxides present. As these proportions change the density of the glass changes. Winkelmann and Schott used the following formula.

$$\frac{Z_1}{X_1} + \frac{Z_2}{X_2} + \frac{Z_3}{X_3} + \frac{Z_4}{X_4} = \frac{100}{S}$$

where S is density of the glass, Z_1, Z_2, Z_3, percentages of oxides present, and X_1, X_2, X_3, densities of oxides in the combined state. These densities are the product of the true density of the oxide and a constant which depends on the oxide itself. The name "density factor" is given to the value of the density of the oxide in the combined state. The density factors are determined by taking a large number of glasses, analyzing them and determining the densities, and trying to find values for X_1, X_2, which will fit in the above equation for the greatest number of glasses. The following table gives the density factors proposed by different investigators.

TABLE I

TABLE OF DENSITY FACTORS

	SiO_2	CaO	MgO	Na_2O	Al_2O_3
Winkelmann and Schott	2.3	3.3	3.8	2.6	4.1
Tillotson	2.3	4.1	4.0	2.8	2.75
Baillie	2.24	4.30	3.25	3.20	2.75
English and Turner	2.20	3.30	3.38	3.47	2.75

The additive effect of the specific volumes of the various oxides as minor changes occur in the composition depends altogether on the total quantity of each oxide present before and after the proposed change. For the particular type of glass whose analyses are given later, the following set of density factors give fairly concordant results.

TABLE II

SiO_2	2.34	MgO	3.84
CaO	2.94	Al_2O_3	3.48
Na_2O	2.96		

When the various density factors are used in calculating the density, the results are:

TABLE III

Glass No.	Density (observed)	Density (calculated)				
		(1)	(2)	(3)	(4)	(5)
1-A	2.4910	2.439	2.49	2.49	2.485	2.49
2-A	2.4432	2.40	2.44	2.43	2.418	2.45
3-A	2.4722	2.42	2.47	2.46	2.44	2.475

In this table the results under density (calculated) are obtained from using the density factors proposed by (1) Winkelmann and Schott, (2) Tillotson, (3) Baillie, (4) English and Turner (using 4.2 for CaO), (5) suggested by P. for glass of this general type. There are rules for operating glass tanks that are generally recognized if well-melted cord-free glass is desired. Among others, the following are important: (1) avoid hot and cold spots on the surface of the glass, (2) keep heating value of all gaseous fuel well up, (3) keep tank "pull" fairly constant and not too great, (4) avoid running the tank at too low a temperature for the "pull," and (5) keep the condition and quality of the fire about constant. An unannealed or a poorly annealed piece of glass will have a lower density than a well-annealed sample. This is due to the fact that in a well-annealed sample all parts cool so evenly that the outside surfaces do not become chilled and set while the interior is still hot and expanded. When such chilling and setting occur, the final bulk is greater and consequently the density is less. The following table illustrates the variations in density of the glass that may occur in a tank. These samples were taken from the tank after the glass had cooled, *in situ*.

TABLE IV

	Position in the tank	Density
(1)	From 1 ft. below surface, 4 ft. from r.w.℄m.e.	2.4480
(2)	" bottom, 4 ft. from r.w.℄m.e.	2.4459
(3)	" " 4 ft. from l.w.℄m.e.	2.4508
(4)	" " 3 ft. from bridge, c.m.e.	2.4498
(5)	" surface, 4 ft. from l.w.℄m.e.	2.4497
(6)	" 1 ft. below surface, 4 ft. from l.w.℄m.e.	2.4515
(7)	" surface, 3 ft. from bridge, c.m.e.	2.4474
(8)	" " 4 ft. from r.w.℄m.e.	2.4497
(9)	" 1 ft. below surface, 3 ft. from bridge, c.m.e.	2.4492

r.w. = right wall
l.w. = left wall
c.m.e. = on longitudinal center of melting end
℄m.e. = on latitudinal center of melting end

Sometimes a sample of the glass taken from a single flowspout has a density that is not representative of the whole tank. To guard against this it is customary to take a sample coming from each flowspout. The following table shows how much variation may be expected if each sample is considered separately.

TABLE V

Flowspout	Density	Flowspout	Density
(1)	2.4471	(5)	2.4493
(2)	2.4486	(6)	2.4500
(3)	2.4484	(7)	2.4475
(4)	2.4495	(8)	2.4482

average density 2.4486

As an example of the way in which the composition of the glass changes in an uncontrolled tank the following case is cited. The three samples 1A, 2A and 3A were all from the same tank and supposedly the same batch was used.

TABLE VI

FACTORY X. TANK NO. 1

	Lab No. 1A	No. 2A	No. 3A
Date	3/23/21	8/27/21	10/5/21
Density	2.4910	2.4432	2.4722
SiO_2	73.75%	77.02%	74.91%
R_2O_3	.67	.58	.70
CaO	9.25	6.81	7.11
MgO	.63	.46	.46
Na_2O	15.06	15.30	16.35

Here is a case where density control would have kept the composition within reasonable limits and the uniformity of the glass would have been maintained. This method of density control was used to supplement chemical analysis, not to supplant it. It was found helpful in control work, but there are many points about its nature and use where further research is desirable. E.J.V.

The flow of glass in tanks. S. R. SCHOLES. *Glass Ind.*, 9 [6], 126–27 (1928).—In rating the tonnage drawn from a glass tank, the expression in general use is the number of square feet of melting area per ton drawn. Where the tank is 40 in. deep, each square foot of melting area corresponds to $3\frac{1}{3}$ cu. ft. of glass, weighing 500 lbs. Standard practice in tanks of the conventional type in use for bottles and other hollowware allows 10 sq. ft. melting area per ton of glass drawn per day. With the glass 40 in. deep, this means 5000 lbs. or $2\frac{1}{2}$ T. of glass present in the melter, for each ton drawn through the throat. On the average, therefore, the glass remains in the melter $2\frac{1}{2}$ days. It seems obvious that this time is longer than should be necessary to plain off the glass in a tank. The chief reason for the relative slowness of the tank process may be found in the manner in which the glass flows through the melting chamber, from charging end

to throat. When the residual glass is removed from a cold tank at the end of a fire, there is found a dark brownish green layer, varying in depth from 6 to 12 in., covering most of the bottom of the melting end. Up to the time it was let out of service, the tank had been producing glass of good color, at least free from such streaks and cords as would be caused by the movement of the dark layer through the throat into the working end. This dark layer has been stationary. It makes up about 15% of the contents of the melting chamber. While no such dark glass can be found at higher levels in the corners of the tank, there is reason in the belief that here, also, the glass is relatively stagnant. Molten glass flows faster in the middle than near the sides and in the corners of the tank. It may safely be estimated that this retardation has the same effect as though an added 10% of the glass did not move. A third factor producing inequality of flow between various parts of the glass stream is the temperature gradient between top and bottom. In the absence of reliable data, the rate at which temperature falls through the depth of a tank-full of glass can only be guessed at. That it does fall, may be accepted without question. And in a viscous liquid like glass, whose fluidity falls off rapidly with decrease of temperature, the result of a relatively small degree of cooling would be to change to a marked extent the relative velocity of flow. A more complex problem is presented when the behavior of melting batch and cullet is considered. Here there are two opposing tendencies: (1) sinking of the new-melted material because it is cooler and therefore heavier than the bath, (2) a buoyant action, due to the evolved gases which tend to lift the new glass and keep it near the surface. There is conclusive evidence that eddying and mixing goes on as new material is added to the bath. The limited experience with the new tanks in which the melting chamber is of the trough or channel type, much narrower in proportion to its length, points to a different behavior during the melting process. In such tanks, the flow of the glass seems to involve more equally the entire contents of the tank. Consequently, although the depth of glass is often only 18 in. instead of 42 in., it has been found possible to draw one ton of glass from each 10 sq. ft. of melting area. Several forms of these tanks have been devised. They differ essentially in the manner of firing and of getting the flue-gases back near the fire port, for the purpose of regeneration or recuperation. The point to be emphasized is that the trough-type tank is a more effective melting unit because of the normal flow of the glass which it contains. So far this type of tank has appeared in small units. The development to be anticipated is the adaptation of the principle to larger units, with less wall-surface exposed per ton of glass carried, relatively less loss of heat by radiation, and higher heat efficiency. E.J.V.

Chantereine Plate Glass Works. ANON. *Glass Ind.*, **9** [6], 127–30 (1928).—A well-illustrated description and discussion of the Chantereine Plate Glass Works of the St. Gobain Co., built as a result of the World War to replace the 2 oldest glass works of this company, one founded in 1692 at St. Gobain and the other in 1800 at Chauny. The new plant is situated on a carefully selected site and the general arrangement and equipment of the workshops have been studied with a view to reducing manual labor to a minimum. This is the most modern plate glass works in Europe. E.J.V.

Scratch polishing of glass. ANON. *Nat. Glass Budget*, **44** [5], 11 (1928).—One of the most important operations which a glass jobber, who operates a grinding, beveling, and polishing shop faces before sending out his glass to the trade is scratch polishing. Glass will often show, hair lines and scratches due perhaps to some minor conditions under which the glass has been manufactured. Again it may be due to climatic conditions or even the equipment that has been used in producing the glass. In order to get this glass in first class condition with a fine luster it is necessary to have the glass polished on a scratch wheel with a good quality of rouge which will cut and polish these objectionable marks from the plate. On the rim or outside circumference of this scratch

wheel a layer of wool felt performs the delicate service of holding the rouge that removes these blemishes from the face of the glass. A pure virgin wool felt is best used to obtain advantages in price and service. E.J.V.

Glass technologists tour Germany. I. ANON. *Pottery Gaz.*, **53** [612], 952–57 (1928).—The new bulb factory of the firm of Osram is located at Siemensstadt. The glass manufacturing operations are mechanical, straightforward, and progressive; there is an uninterrupted forward movement from the first process to the last. The batch melting tanks are operated by producer gas and the bulbs blown automatically by Westlake machines, annealed, and finished with a minimum of handling. Plans call for the installation of four tanks, each operated by four Westlake machines with an additional department for the production of glass tubing and rod. Lignite briquets are used as fuel in the gas producer where they are brought up to 400°C. The main advantages of this gas producer system are (1) the production of a good clean gas and (2) the realization of fuel economy in marketing the tar which reduces the cost to about 11*s.* per T. Without the recovery of the by-products the price would be almost 50% higher. E.J.V.

Elastic constants of glass. E. P. PERMAN AND W. D. URRY. *Chem. and Ind.*, **47**, 502 (1928).—Particulars are given of determination of the compressibilities of soda-glass and Jena 16 III glass at 6 temperatures between 30 and 80°C. For the soda-glass used, c, the compressibility coefficient per atmosphere, is given in terms of the temperature t°C by the relation $c=238+0.185t$. For Jena 16 III $c=220.6+0.28t$. Poisson's ratio, σ, is $0.2207-0.00012t$ for soda-glass and $0.2475-0.00068t$ for Jena 16III. H.H.S.

The behavior of glass as a dielectric in alternating current circuits. I. Relation of power factor and dielectric constant to conductivity. LOUISE S. MCDOWELL AND HILDA BEGEMAN. *Phys. Rev.*, **31**, 476–81 (1928).—Power factor, dielectric constant at 1000 cycles and apparent resistivity for 6 glasses of varying compositions, both including Pb glasses and borosilicates with and without Pb, were determined at 20°. The values of the apparent resistivity at 20° were found by linear extrapolation, by means of the equation $\rho=e^{k/T}$, from values calculated from the measurements of the resistance of small rods at temperatures between 100° and 500°. In 2 cases studied the power factor of strained samples was about 50% greater than after annealing. No explanation is offered. For glasses of relatively similar composition both the power factor and the dielectric constant increase with increasing conductivity. The results indicate a close relation between the phenomena of absorption and ionic conductivity and are shown to be in qualitative agreement with the theory of Joffe (cf. Sinjelnikoff and Walther, *Z. Physik*, **40**, 786 (1927)) that the phenomena of absorption are due to a counter-e.m.f. of electrolytic polarization. Possible alternative molecular explanations are suggested. (*C. A.*)

PATENTS

Tungsten filament. FRITZ BLAU, FRITZ KOREF, AND KURT MOERS. U. S. 1,670,292 May 22, 1928. The process of preparing a filament from tungsten that does not readily assume the macrocrystalline form when heated, which consists in producing at a plurality of points spaced along the filament strains sufficient to form nuclei of crystallization to promote macrocrystallization and then heating to cause macrocrystalline growth to set in.

Laminated glass. WILBUR F. BROWN. U. S. 1,670,435, May 22, 1928. As a new article of manufacture, a sheet of laminated glass including a sheet of glass having a skin of cellulose material thereon which has been coated with a film of nonsolvent *animal oil*.

Laminated glass. WILBUR F. BROWN. U. S. 1,670,436, May 22, 1928. As a new

article of manufacture, a sheet of laminated glass including a sheet of glass having a skin of cellulose material thereon which has been coated with a film of nonsolvent *mineral oil*.

Annealing glassware apparatus. EVERETT O. HILLER. U. S. 1,670,769, May 22, 1928. Apparatus for annealing glassware, comprising an annealing tunnel, means for directing a current of gaseous medium into the tunnel, and means for reversing the direction of flow of the current longitudinally of the tunnel to counteract other currents of air tending to enter the tunnel by reason of a differential atmospheric pressure at opposite ends of the tunnel.

Molten glass delivery apparatus. HENRY W. INGLE. U. S. 1,670,770, May 22, 1928. Apparatus for delivering compact mold charges of molten glass en masse from a glass feeder to a mold, which comprises a delivery member mounted on a horizontal pivot, and means for swinging the delivery member below its pivot axis to move the member between a position in which it is out of operative relation with both the feeder and with the mold and a position in which it is in operative relation with both the feeder and the mold to deliver a mold charge to the mold.

Apparatus for drawing glass articles. ARTHUR E. SPINASSE. U. S. 1,670,909, May 22, 1928. A glass drawing bait for forming hollow glass objects comprising a roof portion and a depending flange having an inwardly extending supporting ledge, for supporting a glass cylinder without adhering thereto, the roof portion having an opening therethrough relatively small compared with the diameter of the bait, and means separated from the bait for directing a jet of air through the opening, the air jet means being of such size relative to the opening and so disposed relative thereto as to provide a passage between the interior of the bait and the atmosphere.

Apparatus for and method of drawing glass. ARTHUR E. SPINASSE. U. S. 1,670,910, May 22, 1928. Means for drawing hollow glass articles comprising a hollow bait having a cross-dimension relatively smaller than that of the hollow article to be drawn, of a tube providing an elongated passage extending from the bait and having its end opening which is remote from the bait open to the free atmosphere, the cross-dimension of the tube interior and opening being relatively smaller than the diameter of the bait, of a fluid pressure member having its discharging opening relatively smaller in cross-section than that of the tube or opening and being arranged to discharge fluid pressure in the tube opening and through the elongated tube whereby to expand and form the hollow article drawn by the bait.

Method of and apparatus for making tubing. WILLIAM J. WOODS. U. S. 1,670,947, May 22, 1928. (1) The method of making tubing which comprises the steps of heating a piece of preformed tubing, attaching it to a holder, supplying a charge of molten glass to a mold whose configuration conforms to the desired shape of the blank, inserting the tubing in this molten glass, leaving the preformed tubing in the molten glass in the mold until the former has become incorporated with the latter and the latter has set, and drawing the blank thus formed into tubing of the desired size. (2) An apparatus for making tubing blanks, comprising a framework, a mold pivotally supported thereby, a recess in the mold, a punty inserted through the recess with its head exposed in the mold, a holder for supporting a piece of preformed tubing, and means for regulating the position of the preformed tubing with reference to the cavity in the mold.

Sheet-glass production. PAUL F. GUTMANN. U. S. 1,671,073, May 22, 1928. In combination with a glass melting furnace, a horizontally disposed drum having an intake opening at one end thereof in operable relation with a discharge opening of furnace and a horizontal opening in the side thereof parallel to its axis, means for rotating the drum on its axis, and glass sheet forming means in operable relation with the horizontal opening in its discharge position and a support member having a receiving surface in operable relation to the sheet forming means and being movable to receive the sheet in a flat position thereon as it is formed.

Making a lens blank. WALTER C. SCHLITZER. U. S. 1,671,548, May 29, 1928. The method of making a lens blank which consists in heating a piece of glass to a viscous state while supporting it entirely outside of its lens forming area, then supporting the glass over a mold, and moving a plunger to stamp out the lens forming area and force it into the mold, at the same time severing the lens forming area from the supporting area.

Plate-glass transfer and laying apparatus. HALBERT K. HITCHCOCK. U. S. 1,671,766, May 29, 1928. In combination in apparatus for laying glass sheets on a series of cars or carriers mounted on a track, of a crane mounted over the track for movement longitudinally of the track, a plaster mixing and applying apparatus carried by the crane, and roller means carried by the crane for pressing the glass sheets into the plaster.

Glass inspection apparatus. WILLIAM O. LYTLE. U. S. 1,671,772, May 29, 1928. The combination with a carrier or runway for sheet glass having a bed comprising spaced supports for the glass, of an inspection device comprising a source of illumination on one side of the bed, an inclined polarizing reflector in position to receive the light from the source of illumination and reflect the polarizing portion thereof between the spaced supports and through the glass carried thereby, a 2nd inclined reflector extending across the runway above the glass on the other side of the bed in position to receive the polarized light transmitted through the glass from the 1st reflector and to transmit it laterally, and an analyzer located at one side of the runway in position to receive the light reflected from the 2nd reflector.

Manufacture of plate glass. MAX BICHEROUX. U. S. 1,673,098, June 12, 1928. Process of forming plate glass which comprises delivering the contents of a melting pot en masse onto a receiver adjacent to a forming pass, the delivery being effected by turning the pot about a horizontal axis located near the upper pouring edge of the receiver, accumulating the glass on the receiver in a compact mass and feeding glass directly from the mass to a forming pass.

Pressing glass. ROBERT L. ELLERY. U. S. 1,673,108, June 12, 1928. In a glass press, a mold carrier mounted upon a horizontal axis, a series of molds mounted on the carrier, each mold comprising a fixed mold plate and an oscillatable mold plate pivoted near one edge upon a horizontal axis, the mold plates being arranged to form a V-shaped opening therebetween when the oscillatable mold plate is moved to open position, and to press a plate therebetween when the oscillatable plate is moved to closed position, means to move the carrier intermittently and means to close the molds successively while the carrier is at rest, the means being in position to actuate the mold having its oscillatable mold plate pivoted at its lower edge.

Laminated product. FRAZIER GROFF. U. S. 1,673,239, June 12, 1928. Method of making a laminated structure comprising impregnating a fibrous base with a resin of the glycerolphthalic anhydride type, drying the sheet to expel solvent and to set the resin, superposing the sheets with interposed reactive phenolic resin, and consolidating by application of heat and pressure.

Method of annealing. CLARENCE ROSS GALE STEWART. U. S. 1,673,271, June 12, 1928. A method of simultaneously annealing a plurality of materials of different character, which consists in associating the materials together, subjecting them to a sufficiently high temperature to anneal both materials simultaneously and to cause one material to evolve a gas which interacts with the other material.

Manufacture of raw plate glass. MAX BICHEROUX. U. S. 1,673,347, June 12, 1928. Apparatus for manufacturing raw plate glass adapted to be ground and polished, comprising a plate glass pot, a pair of rolls, means for tilting the pot so as to discharge its whole contents quickly in front of the rolls and means for dividing the glass discharged from the pot into several juxtaposed portions.

Glass polishing apparatus. CHARLES H. CHRISTIE. U. S. 1,673,733, June 12, 1928. The combination with a glass polishing block, of a ring, a polishing pad supported by the ring and having its edge upturned and held against the periphery of the ring, and means for detachably securing the ring to the block, the block being provided with an integral portion overhanging and directly engaging an upper portion of the ring in order to support the ring rigidly against upward movement relative to the block.

Blowing glassware. GEORGE E. HOWARD. U. S. 1,673,747, June 12, 1928. The method of blowing glassware that comprises the step of passing air simultaneously into and out of the interior of the glass after the glass has been expanded to fill the mold, thereby hastening the cooling of the glass.

Glass manufacture. H. HILLMANN. Brit 287,067, May 2, 1928. A bottle-blowing machine in which a parison is transferred from a parison mold to a finishing mold by means of the ring mold, which reciprocates vertically between the two molds. The means for reciprocating the ring mold is so constructed that the mold descends to a fixed lower level while its upper level is determined by the position of the parison mold. The machine gathers charges of glass by suction from a mass of molten glass contained in a tank. The molds are carried by a frame which rotates about a fixed central column. The finishing molds are carried by brackets adjustably secured to the frame, and the parison molds are supported by carriages which are reciprocated in vertical guides in the frame. Each mold carriage is connected by a link with a lever which is rotatable about a shaft, a spring being interposed to form a resilient connection between the link and the lever. A segmental cam member, also mounted on the shaft, is rigidly connected with the lever. The ring mold is supported by a carriage which slides in vertical guides in the frame and is connected by a link with a lever. This lever is pivoted to a 2-armed lever and has a central roller which rests on the segmental cam. The lever is pivoted on the shaft and carries a roller which runs on a cam fixed to the central column. In use, the ring mold rests on and moves with the parison mold, when the latter dips to gather a charge, since the roller rests on the upper side of the segment cam. When the parison mold opens, the cam remains stationary, and the roller moves inward along the cam. The arm and the pivot thus rise, the roller runs off the top of the cam and moves down the circular face, and the ring mold descends on to the finishing mold. When the parison mold is changed for one of a different height, the highest position of the ring mold adjusts itself to a new level since the roller rests on the upper side of the cam which is fixed in relation to the mold carriage. The device enables the ring mold to be moved by a fixed cam, irrespective of the length of the parison mold.

Glass manufacture. NAAMLOOZE VENNOOTSCHAP PHILIPS' GLOEILAMPENFABRIEKEN. Brit. 287,131, May 9, 1928. A machine for melting off the waste portions of glass bulbs after they have been blown and before they are made up onto electric lamps. The devices which hold the bulbs grip them by suction, and means are provided for centering the bulbs in the holders and for removing them from the holders when they are finished. The machine comprises a carrier which is rotated intermittently about a shaft and is provided with bearings in which bulb holders in hollow bushes are journaled. Pinions secured on the bushes engage a gear wheel mounted on, and constantly rotated by, the shaft. The bushes have cupped lower ends which engage the bulbs and they are also formed with slots by means of which their interior spaces communicate with passages formed in the carrier and thence with a vacuum tank. Brackets are secured to the carrier adjacent to the holders, and carry adjustable lugs. A pin slides into the hollow interior of each holder and is normally pressed upward by a spring. In use, a bulb is pressed against the cupped end of a holder and is held by suction. The holder is in constant rotation, and unless the bulb is correctly centered, it is brought into contact with a lug which is so adjusted as to straighten the bulb in

the holder. A burner mounted on the table of the machine then fuses off the glass at the neck of the bulb. Movement of the carrier eventually brings the bulb beneath an arm which projects over the carrier. This arm engages the upper end of the pin and presses it downward, thus causing it to eject the bulb from the holder.

Heavy Clay Products

New form of building tile. HANS KLÄR. *Ber. deut. keram. Ges.*, **9** [2], 69–76 (1928).—A new type of hollow tile is proposed. The shape of the tile, methods of laying it, and advantages of such a building unit are given. F.P.H.

Sand-lime paving stone. B. KRIEGER. *Tonind. Ztg.*, **52** [12], 207–208 (1928).—The properties of some sand-lime brick that have been impregnated with bituminous materials to make them suitable for paving blocks are given. F.P.H.

Separation of solid material from liquids with special reference to clay material. ADOLF POHL. *Tonind. Ztg.*, **52** [16], 277–79 (1928).—A vacuum filter for the filtration of clays is described and illustrated. The material is filtered onto an endless twine belt, dried, and passed over a small roller which breaks up the filter cake and discharges it into a hopper. F.P.H.

Heat economy in the brick plant. W. LEDER. *Tonind. Ztg.*, **52** [18], 317–21; [20], 369–73; [23], 442–45 (1928).—The following subjects are discussed: (1)heat economy in the steam plant, (2) heat economy in the ring furnace, (3) heat economy in the drying plant, with special reference to the utilization of waste heat. A comparative summary is given on the basis of 1000 brick on boiler efficiency, fuel consumption, power consumption, fuel cost from data collected from 20 various plants. F. P. H.

Drying buildings. AMOS HOHENDOLZSCHEN. *Tonind. Ztg.*, **52** [24], 467 (1928); *Rock Prod.*, **31** [11], 88 (1928).—H. points out that rationalization of building construction must deal with securing dry buildings. Building construction of today requires rapid and economical erection of apartment buildings ready for occupancy after a minimum period of time. The moisture collecting in new buildings due to the masonry or concrete work or to the weather has disadvantages as it reduces the heat protection afforded by the walls by nearly one-half and disappears slowly with ordinary airing. Tests were made of artificial drying of new apartment buildings with coke ovens. The disadvantages and limited results of the latter have led to special processes insuring the drying of a building in a few days with relative economy by means of hot air. By this method a building can be occupied several months earlier than when natural airing is depended upon. F.P.H.

The salt glaze in thin section. W. FISCHER. *Keram. Rund.*, **36**, 165–67 (1928).—A microscopic study of thin sections of salt-glazed ware, the thin section being cut normal to the glaze-body contact shows (1) the more densely fired the body the sharper the boundary between glaze and body, (2) the thickness of a normal salt glaze is 0.01 to 0.05 mm., (3) the longer the period of salting the greater the thickness of the glaze, although the increase in glaze thickness is greater in the early periods, (4) the salt glaze is heterogeneous and tends to crystallize, (5) the thicker the glaze the greater the crystallization tendency. Imperfect (foamy or silvery) salt glazes are characterized by glaze thickness and by octahedral crystals arranged in bands or cords and often as skeleton forms which are probably composed of Fe_2O_3 with dissolved FeO and of ilmenite. H.I.

Reinforced brickwork. ANON. *La Céramique*, **30** [471], 97 (1927).—The ideas underlying the use of "reinforced brick" in a similar fashion to reinforced concrete are explained and illustrated. A.E.R.W.

Reinforced brick, a complete building material. L. ATTHENONT. *La Céramique*, **30** [471], 98–104 (1927).—A. has invented a new construction method using reinforced

brick or hollow tile in the same way that reinforced concrete is used. The tests made to determine the elasticity and strength of units consisting of hollow blocks reinforced with steel are described and diagrams given showing the assembly of units for use in making telegraph poles, floors, walls, ceilings, etc. In some cases steel plates are placed between the bricks to oppose shearing forces. The cost of building with reinforced brick is compared with that of building with reinforced concrete and found to be smaller. A.E.R.W.

Specifications for first-class, fired-clay, flat tiles. ANON. *La Céramique*, **30** [471], 106–107 (1927).—Specifications of the Brick and Tile Section of the "Syndicat des Fabricants de Produits Céramiques de France." A.E.R.W.

Illinois Clay Manufacturers' Association 50th anniversary. ANON. *Brick Clay Rec.*, **72** [11], 772–75 (1928); *Ceram. Ind.*, **10** [6], 638–39 (1928).—A report of the semi-centennial meeting of the Illinois Clay Mfrs. Assn. at Urbana, Ill., May 10 and 11, 1928. Papers presented included "An Appreciation of the Associations' Contribution to Ceramic Education," by H. C. Arnold; "The Value of a Daily Log of Plant Operations," by E. H. Van Schoick; "Searching Out the Road of Progress," by F. L. Steinhoff; a résumé of the work of the N.B.M.A. in its investigation of driers, by R. K. Hursh; "The Development of the Strength of Segmental Sewer Blocks," by John G. Baer; "Ceramics and the Telephone," by O. L. Mundy; "The Application of X-Rays to Ceramics," by T. N. McVay; and "Pin Holes and Blisters in Enamels," by K. B. Strong. "The Story of Carborundum Refractories" was a film presented by the Carborundum Co. In a paper on "The Use of Color in Ceramics," Rexford Newcomb pointed out that utility, durability, form, and color are the four characteristics in which the general public is now chiefly concerned. Color is by no means the least important, especially in an age where color has come to the front for consideration as it has in our time. N. traced the history of architecture and the part played by color and ceramics in the nations of antiquity. E.J.V.

Paper packaged brick. ANON. *Brick Clay Rec.*, **72** [11], 776–78 (1928).—Superseding the old method of packing brick between straw or similar materials when shipping by railroad (a method which, in many cases, proved ineffectual to prevent breakage) some brick companies are setting their brick between rows of heavy indented paper to prevent damage in transit. This method, it is said, has prevented breakage and has speeded up unloading when the shipment has reached its destination. E.J.V.

Big business from a small town. ANON. *Brick Clay Rec.*, **72** [11], 780–81 (1928).—A description of the 5-kiln plant of the Woodlawn Clay Products Co., of Woodlawn, Ill., whose entire output of fireproofing and drain tile has been contracted for the next three years. E.J.V.

Conveying products to railroad. ANON. *Brick Clay Rec.*, **72** [12], 842–43 (1928.—A description of the use of 1000 feet of gravity conveyers to move the products of the Independent Brick & Tile Co., Cleveland, Ohio, 600 feet down a hill to the railroad track for loading. The conveyer system was devised only as an emergency measure until a siding could be negotiated for but served for seven years, during which time 3700 carloads of tile and 50 cars of brick passed over the belts. E.J.V.

Frictionless equipment. HENRY C. KLEYMEYER. *Brick Clay Rec.*, **72** [12], 844 (1928).—A discussion of the savings effected in clay plant operation by the use of ball bearing motors, line shaft bearings, and frictionless bearings on wheel barrows and trucks for handling brick and clay products in general. Actual data from personal experience is presented. E.J.V.

Saving on unloading costs. ANON. *Brick Clay Rec.*, **72** [12], 851–52 (1928).—A description of the method of reducing handling costs on brick devised by the Tuttle Bros., of Wesfield, N. J., for use in their supply yards. Brick are "packaged" on pal-

lets accommodating 84 brick on a course, six courses high, with four brick removed to make a "package" of 500 brick. These pallets of brick are handled with an electric crane and overhead tramrail. Savings effected by use of this method amount to $1.20 per thousand brick. E.J.V.

Roseville experimental plant research laboratory ANON. *Brick Clay Rec.*, **72** [12], 847–49 (1928); *Ceram. Ind.*, **10** [6], 640–41 (1928); *Ceram. Age*, **11**, [5], 189–90 (1928); see also *Bull. Amer. Ceram. Soc.*, **7** [7], 222 (1928).

PATENTS

Cellular building block. HAROLD S. ASHENHURST. U. S. 1,671,216, May 29, 1928. A unit block for a wall, made up principally of body material of cellular formation throughout and having at least one face defined by cell depressions separated from each other only by the cell walls and provided by the removal of the outer portions of the cells.

Insulated wall. HAROLD S. ASHENHURST. U. S. 1,671,266, May 29, 1928. A wall comprising in combination two supporting wall sections in spaced relation to each other, at least one of the sections being built up principally of hollow tile with some of the tile at intervals throughout the face of the wall section provided with openings into the interior hollow spaces, and a monolithic body of cellular insulating material filling the space between the two sections and extending through the openings into the interior spaces of the tile serving both to insulate the wall and also to bond the two sections together mechanically.

Building block and wall construction. HUGO WITTMAN. U. S. 1,671,501, May 29, 1928. A hollow building block provided with two sides of unequal height, one horizontal wall of one side lying in substantially the same plane as the corresponding wall of the other side, and the other horizontal walls of the two sides lying in planes which are spaced apart a distance equal to the height of a brick and a mortar bed, and of less height than the height of two bricks and a mortar bed, the lower side being of greater height than that of a brick and a mortar bed.

Tile. CARL GROSS. U. S. 1,672,886, June 12, 1928. A tile including a polygonal block body having notches at its lower corners to form shoulders adapted to rest on thrust supporting structures, a laterally extending tongue formed at one corner below the shoulder of the notch thereof, the block body being of hollow reinforced construction and comprising top and bottom spaced horizontal walls and side walls which incline outwardly and downwardly, the faces of the shoulders being horizontal and the upper face of the tongue being inclined downwardly and outwardly.

Brick-molding machine. DUNCAN GORDON MACKENZIE. U. S. 1,672,619, June 5, 1928. A machine for molding brick, tile, road sets, and other articles, by pressure from aggregate, comprising a member which is adapted to be rotated step by step in one direction only, a 2nd member adapted to be rotated to and fro, molds consisting of stationary bottom walls carried by the 1st mentioned member and side walls slidably mounted on the member, means for moving the slidable mold walls, and a ram for compressing or consolidating the contents of the molds, substantially as described.

Brick machines. J. P. MARTIN. Brit. 286,591, May 2, 1928. Comprises improvements in brick machines of the type wherein molds are fed beneath a charging-chamber and are subsequently discharged by a reciprocating pusher, the filled molds being inverted for delivery of the bricks and, when emptied, passed to a sander. The charging-chamber is arranged exteriorly of a vertical pugmill, fitted with a shaft carrying blades and a wiper which delivers clay to the chamber. A plunger cuts off and delivers the clay to the mold through a die. To adjust the compression on the clay, the plunger is operated by a crank and rod through an adjustable screw carrying a bumper plate adapted to engage a plate supported in appropriate slots in a slide carrying the

plunger. The screw is adjustable through bevel gearing adjustable directly by a handwheel or indirectly through sprocket gearing. The pusher is reciprocated by a crank through a rod having a screw adjustment at one end and at the other a breakable connection comprising a shear pin connecting telescopic portions. A main shaft drives the crank through spur gearing and the crank shaft drives through gears and a chain and sprocket, the shaft operating the sander. To avoid damage, a breakable connection is interposed between the sprocket and shaft and comprises a driver integral with the sprocket, which driver engages a plate pivoted between jaws on a member secured to the shaft, and normally secured by a shear pin passed through holes in the plate and jaws. For discharge, the molds are dumped on fixed stop members comprising a pair of brackets having arms fitted with rollers, down which an empty mold can slide and pass to rollers leading to the sander. The pugshaft is driven from the main shaft through sprocket, spur, and bevel gearing including a shaft which drives the crank through spur gearing. The charging chamber may be associated with a horizontal pugmill.

Brickmaking. G. H. HADFIELD. Brit. 286,772, May 2, 1928. Bricks are made of clay mixed with clinker from boiler ash, house refuse, destructor ash, etc., which has been substantially freed from carbonaceous material by known methods.

Cutting glass. W. MERCK. Brit. 287,172, May 9, 1928. A device for opening sealed glass tubes comprises means for cutting the glass and means for striking the part of the tube to be removed. The apparatus comprises a base-plate having an elongated recess or slot along one edge of which a cutter is disposed. The holder of the cutter is free to slide to and from the slot, but is forced toward it by a spring. A rod, having a cranked arm, is journaled in bearings secured to the base-plate and is surrounded by a coiled spring. A knob on the other end of the rod is provided with a pin which can engage a spring-operated latch. A bell-crank lever pivoted on the underside of the base-plate, has one arm projecting across the slot while the other arm engages an arm of a lever, also pivoted on the base-plate. The other arm of the lever is bent upward to form the latch. In use, the knob is turned to rotate the rod against the action of the spring until the pin engages the latch and the cranked arm is set in position. The neck of the sealed glass tube is passed along the slot and makes contact with, and is cut by, the cutter. When it reaches the end of the slot the tube presses against and moves the lever thus causing the latch to release the pin. The spring then rotates the rod and the cranked arm strikes and breaks off the end of the glass tube. In a modified construction, the recess and the cutter are formed in and on two scissors-like members. The striker is pivoted on the member, and it is moved backward, against the action of a spring by means of a lug on the member which engages a pin on the striker. In operation, the tube neck is inserted in the recess and the members are closed. A spring-pressed member holds the tube neck against the cutter and the striker is swung backward until it is released by the lug, when it swings forward and strikes the tube.

Glass manufacture. E. E. FISHER. Brit. 288,267, May 31, 1928. Barium sulphate is used as a constituent of batches for making transparent glass. The batch must be free from carbonaceous material or other reducing agents in order that selenium may be used for decolorizing. It is preferred to use about 4 lbs. of barium sulphate for each 100 lbs. of sand in the batch, larger quantities tending to form "salt water" on the surface of the molten glass. Suitable batches for the production of bottles and window glass are given.

Glass manufacture. W. J. MILLER, INC. Brit. 288,342, May 31, 1928. In a machine for making glassware, the parison molds receive charges of glass during continued movement in an upright position past a charging point, and each mold is provided with a coöperating parison-forming element at its upper end, means being also provided for

applying suction to effect a downward pulling on a charge of glass entering the mold to cause it to conform to the walls of the mold. After a charge has entered the mold, pressure may be applied from above to compact the glass and expand it in the mold. The mold table consists of a hollow hub, which rotates about a hollow column and is formed with a number of hollow arms. The pipes for conveying compressed air to the molds are led through the hollow arms, and air for cooling the molds passes through the spaces in the arms. Each set of molds, with its operating-gear, is carried by a structure consisting of an upper and a lower frame which are bolted together. The whole structure, with the molds completely assembled, can be lifted on to a pair of table arms and when placed in position, ports in the mold structure register with corresponding ports in the arms to which the air supply pipes are connected. The halves of the parison mold are clamped to holders, hinged on a pin, and opened and closed by a sliding plate. The plate is operated by a fixed cam and is connected with the mold holders by a spring dog, which yields if the mold resists movement and thus prevents damage to the machine. The pin is eccentrically mounted and may be turned to adapt it for variations in the length of the hinge members. The lower end of the mold closes around the ring mold which is carried by a transfer arm that turns the parison over and tranfers it from the parison to the finishing mold. In order to compact a charge of metal into the parison and ring molds, suction is applied through the ring mold and compressed air through a mold cover which is brought down on to the open end of the parison mold. The mold cover is carried by an arm which is reciprocated vertically, and is swung to one side when raised in order to clear the parison as it turns over. The plug for forming the initial opening in the parison, is moved up and down by a rod operated by a fixed cam. After a charge is compacted, the plug is lowered and air is supplied through the ring mold to blow up the charge to fill the parison mold. The cover has a rounded lower end to shape the bottom of the parison, and it also regulates the length of the parison.

Glass manufacture. W. J. MILLER, INC. Brit. 288,343, May 31, 1928. A machine for forming glassware comprises a stationary base, supporting means movable on the base, and a number of sets of molds mounted on the supporting means, each set of molds and the associated operating-devices being so arranged that they can be mounted on, or removed from, the support as assembled units. The mold table consists of a hollow hub, which rotates about a hollow column, and is formed with a number of hollow arms. The pipes for conveying compressed air to the molds are led through the hollow arms and air for cooling the molds passes through the spaces in the arms. Each set of molds with operating-gear, is carried by a structure consisting of upper and lower frames bolted together. The whole structure, with the molds completely assembled, can be lifted on to a pair of table arms and when placed in position, ports in the mold structure register with corresponding ports in the arms to which the air supply pipes are connected. The halves of the parison mold are clamped to holders, hinged on a pin, and opened and closed by a sliding plate. The plate is operated by a fixed cam and is connected with the mold holders by a spring dog, which yields if the mold resists movement and thus prevents damage to the machine. The pin is eccentrically mounted, and may be turned to adapt it for variations in the length of the hinge members. The holders are hollow, and cooling air passes from the interior of the arms through the holders and is blown on to the mold parts and hinge members. The lower end of the mold closes around the ring mold which is carried by a transfer arm secured to a shaft. This shaft is oscillated by a rack which reciprocates vertically and is operated by fixed cams. The oscillation of the shaft turns the parison over and transfers it from the parison to the finishing mold. In order to compact a charge of metal into the parison and ring

molds, suction is applied through the ring mold and compressed air through a mold cover which is brought down on to the open end of the parison mold. The mold cover is carried by an arm, which is reciprocated vertically, and is swung to one side when raised in order to clear the parison as it turns over. The plug for forming the initial opening in the parison, is moved up and down by a rod operated by a fixed cam. After a charge is compacted, the plug is lowered and air is supplied through the ring mold to blow up the charge to fill the parison mold. The rod slides through a sleeve which acts as a pivot for the finishing-mold holders. The halves of the finishing mold are carried by holders which are hinged on the sleeve and are opened and closed by a sliding yoke operated by fixed cams. The yoke also operates parallel sliding rods which open the ring mold when it is in position on the finishing mold. When the ring mold has been turned over and the finishing mold has closed around the parison, the ring mold is opened and releases the parison and is then swung back under the parison mold to receive a new charge of metal. While the new parison is being formed, a blowhead descends on the finishing mold and completes the blowing of the first parison, so that one parison is being blown while another is being formed. The bottom plate of the finishing mold is hinged to its support and is raised to the mold by a fixed cam. The cam allows the bottom to tilt, when the mold opens, to discharge the finished article.

Glass manufacture. W. J. MILLER, INC. Brit. 288,344, May 31, 1928. A device for coupling parts of a machine for making glassware comprises a detent yieldingly mounted on one of the parts to be coupled and adapted to engage in a recess in the other part, the detent maintaining a definite association of the parts under normal operating pressure but yielding gradually and resiliently, under abnormal pressure and allowing the parts to uncouple. The device is applied to a rod which reciprocates vertically in a sleeve and carries at its upper end a plug for forming the mouth ring. The rod carries at its lower end a roll which engages in cam tracks and raises or lowers the rod. A spring dog disposed in a horizontal aperture in the rod engages a notch in a bolt, depending from the frame of the machine, when the rod is in its uppermost position. The rod is thus prevented from dropping by gravity and is held up until the roll engages the proper cam track to lower the rod. When a charge of glass is dropped into the parison mold, compressed air is admitted above the glass from a blowhead to compact the charge. The dog prevents the plug from being depressed prematurely. A blowhead is carried by a yoke pivoted on a shaft and swung about the shaft by a segment member also pivoted on the shaft, which is moved by the vertical reciprocation of a rod. A latch pivoted on the blowhead is forced by a spring into engagement with a notch on the segment, so that the blowhead and segment normally move as a unit. If the movement of the blowhead is obstructed, the latch becomes disengaged from the notch and prevents breakage of the parts.

Glass manufacture. W. J. MILLER, INC. Brit. 288,345, May 31, 1928. A machine for forming glassware comprises a unit which includes a permanently inverted parison mold, a blow mold in fixed relation thereto, means for swinging the parison by means of the ring mold from the parison mold to the blow mold, and means for returning the ring mold to the parison mold before the completion of the article in the blow mold. The mold table consists of a hollow hub which rotates about a hollow column and is formed with a number of hollow arms. Each set of molds, with operating gear, is carried by a structure consisting of upper and lower frames which are bolted together, and the whole structure can be lifted on to a pair of table arms as a completely assembled unit. The halves of the parison mold are clamped to holders, hinged on a pin, and opened and closed by a sliding plate. The pin is eccentrically mounted and may be turned to adapt it for variations in the length of the hinge members. The lower end of the mold closes around the ring mold which is carried by a transfer arm secured to a shaft. This shaft

is oscillated by means of a reciprocating rack and swings the parison over from the parison mold to the blow mold. The halves of the blow mold are carried by holders which are hinged on a sleeve and they are opened and closed by a sliding yoke operated by fixed cams. The yoke also operates parallel sliding rods which open the ring mold when it has deposited the parison in the blow mold. When the blow mold has closed around a parison, the ring mold is opened and releases the parison and is then swung back under the parison mold to receive a new charge of glass. While the new parison is being formed, a blowhead descends on the blow mold and completes the blowing of the first parison, so that one parison is being blown while another is being formed. The connection between all the moving parts and the cam rolls that operate them is made by spring dogs which yield if the movement is obstructed.

Refractories

Elimination of segregation in drums. G. J. EASTER AND G. M. MAGRUM. *Jour. Amer. Ceram. Soc.*, **11** [7], 582–83 (1928).—Segregation of grits of different sizes was practically eliminated by the insertion of small tangential cylinders (3-inch diameter) extending from top to bottom of the drum while it was being filled.

Fire brick for boiler furnaces. W. A. CARTER. Amer. Refrac. Inst., *Bull.*, No. 22, April (1928).—In spite of the fact that a large number of boiler furnaces are being constructed with water-cooled walls, many boiler furnaces will be made with solid refractory walls or with air-cooled refractory walls, and it is possible that even the furnaces with water-cooled walls will need to be supplemented with firebrick walls in order to insure satisfactory combustion conditions. For either case, a logical method must be followed in selecting the fire brick that will give satisfactory service. Too often fire brick of a certain brand are chosen only upon the recommendation of over-zealous salesmen. Such practice is seldom safe unless it is definitely known that the plants have the same service conditions, *i.e.*, practically identical boiler furnaces, grades of coal, coal burning equipment, load characteristics, etc., which is very seldom the case. The operator of large boiler plants can well afford to give the selection of fire brick more careful consideration than this hit-or-miss method. A logical method to use in selecting a fire brick is to consider the physical properties that it should possess, the results of certain laboratory tests upon various brands of brick, including those used in the actual service conditions under consideration, and then a thorough investigation of the plants and the policies of the company or companies making the brick that give the best laboratory results. Before adopting a brick by this procedure it should be given a thorough set of service tests. The physical properties that should be given consideration are resistance to slag erosion, resistance to temperature shock, spalling, fusion temperature, deformation under load while hot, uniformity of size, thermal expansion, constancy of volume upon repeated heating and cooling, freedom from laminations, and uniformity of composition and firing. The standard test for fusion temperature is reliable, but it gives the fusion temperature of the brick for only one set of gas conditions; the brick in service may be exposed to either oxidizing or reducing gases. The brick would fuse at a lower temperature under the latter conditions. The average uniformity of size can be measured on stacks of ten bricks. Thermal expansion can be accurately measured in the laboratory. The constancy of volume test is a good criterion of the perfection of firing in the kiln. The present tests for resistance to slag erosion are far from satisfactory; in most cases they give erroneous indications of the results obtained in service. A satisfactory test must simulate service conditions as to brick temperature, slag composition and viscosity, and furnace atmosphere. One investigator is developing such a test. The water-dip spalling test subjects the brick to far different conditions than those in boiler furnaces. The development of the spalling test being made by the

American Refractories Institute will result in a more satisfactory test. The standard load test of fire brick while hot does not duplicate service conditions as the brick is heated uniformly throughout, whereas in service there is usually a steep temperature gradient from the hot to the cool faces. Generally the manufacturers are willing to furnish Mellon Institute data on their brands of brick that will show the laboratory results of tests on fusion temperatures, constancy of volume, deformation under load while hot, and spalling by either the water-dip or the tentative air blast tests. An alternate scheme would be for the brick user to have samples of the various brands of brick tested in an adequately equipped ceramic laboratory. All of the brands should be tested in the same laboratory to avoid errors due to difference in laboratory methods. A comparison of these data for the various brands will indicate, with a certain degree of reliability, the brands that appear to have the best combination of physical properties for use in boiler furnaces. Should the impressions gained of the brickmaking operations, as well as the results of the laboratory tests, be promising, service tests should be made. These tests should not be limited to a single trial installation as the results are liable to be misleading, especially if the results of a single trial are good; the brick may not have been subjected to the worst conditions that they would be called upon to meet in the particular furnace under consideration. The brick in the service tests should cover an entire wall of the furnace in each installation, or at least an area of sufficient size that the results will not be influenced by surrounding brick of a different kind. Accurate records should be kept of the boiler operation, the nature of the firebrick failures, if any, as well as the extent and cost of the wall repairs during the service tests. Photographs of the walls during inspection form a valuable part of these records. The service tests are more valuable to both the user and the manufacturer if a well-informed service man follows with the user the performance of the brick. Too often the brick manufacturer does not acquaint himself with the actual service conditions, even during such service tests. After selecting the brand, or brands of brick giving satisfactory results in the service tests the user should draw up from the laboratory tests and elsewhere a workability specification upon such of the physical properties as he can, including fusion temperature, deformation under load while hot, dimensional tolerances, constancy of volume upon repeated heating and cooling, freedom from blemishes, defective corners and cracks, etc. The manufacturer should be given a part of one of his brick that survived the service tests, the user keeping the other, these to serve as a guide for the texture and the fineness of grind desired. The specifications and brick sample should be used when inspecting shipments to insure getting bricks like those originally used in the service tests. F.P.H.

Fire clays of Pennsylvania: Partial report. J. B. SHAW. Top. and Geol. Surv. Pa., *Bull.*, M10 (1928).—This report describes 81 clays of Pa., not all of which are fire clays. A uniform method of sampling was followed as far as possible. Each sample was obtained by cutting a groove from top to bottom of the portion of the stratum being sampled. Each sample weighed about 10 pounds. The samples in the raw state were examined to determine the color, hardness, and visible foreign matter. Color includes white and shades of gray and brown. Hardness is described roughly by the terms, hard, medium, and soft. Fracture is of 3 kinds, earthy, conchoidal, and splintery. Visible foreign matter includes such impurities as iron, carbon, and sulphur compounds. After grinding through a 20-mesh screen the samples were mixed with sufficient distilled water to produce normal consistency. By normal consistency is meant that condition in which the clay is most workable, is no longer sticky, and will not adhere to metal. The "feel" of the clay at or near normal consistency estimated by the operator, is the basis on which it is rated as having good, poor, or fair plasticity. This test was made in every case by the same man, thereby eliminating as far as possible the error introduced

by the personal factor. Other tests carried out on the clay in the green are as follows: (1) water of plasticity, (2) shrinkage water, (3) pore water, (4) drying shrinkage, (5) time of slaking. The briquets which had been used in determining drying shrinkage were fired at 50°C intervals from 1000°C to 1400°C and the porosity, firing shrinkage, and apparent specific gravity determined on these bodies. The fusion point of the clays was determined by use of an oxyacetylene burner in a specially constructed furnace lined with a mixture of 15% alundum cement and 85% fused alumina. The cones were set in cone pats of the same mixture. Experience in recent years has shown that the fusion point must be made under accurately controlled furnace conditions if serious error is to be avoided. The geologic relation of the beds from which the samples were taken range from the top of the Pittsburgh coal to the underside of the Sharon coal. Chemical analyses of 33 of these clays are given. F.P.H.

Influence of firing on the chemical and physical properties of refractory clays. W. MIEHR, J. KRATZERT, AND H. IMMKE. *Tonind. Ztg.*, **52** [16], 280–82; [17], 298–301; [18], 323–25 (1928).—A brief review is made of the literature on the subject. The object of the investigation was to determine the temperature at which clay changes to mullite and to study the relation between mullite content and temperature and duration of firing, grain size, alkaline fluxes, and clay substance content. Twelve clays of different chemical and mineralogical composition were included in the investigation. Microscopic, chemical, and X-ray methods were used in studying the changes in structure. The rational and chemical analyses of the clays were given. Clays containing very little fluxes must be fired at high temperatures and for long periods to produce any appreciable amounts of mullite. In the case of some clays this temperature is above 1550°C. As the flux content is increased the temperature of mullite formation is lowered and the amount of mullite formed is increased by fine grinding of the materials. A highly siliceous clay that has been fired to cone 15 shows the tridymite-crystobalite effect and the α–β quartz effect on the expansion curve. As the firing temperature is increased to cone 17 these two effects are less pronounced and as this temperature is increased to cone 20 they are barely perceptible; the absolute expansion is also reduced. In the case of the cone 20 firing the expansion curve is almost a straight line. The smaller the total expansion and the more uniform its course, the better will the material resist stresses set up by temperature changes. F.P.H.

Refractories for the glass industry. W. J. REES. *Glass*, **4** [11], 468 (1927).—The corrosion of fire clay by glass is dependent upon (1) the rate of reaction between solid clay and liquid glass at the surface of contact and (2) the speed of diffusion. The reaction rate is greater than the speed of diffusion of the products of the reaction so that the rate of diffusion becomes the controlling factor. This rate is inversely proportional to the viscosity of the glass but as the viscosity is increased by the solution of the clay the diffusion is decreased and equilibrium is almost attained. Mullite in a fireclay pot increases the resistance to corrosion. Mullite is developed more readily in an aluminous clay than in a sificeous one. A microscopic study of a pot wall shows numerous distinct layers. Starting from the outside of the pot are (1) mullite and corundum in the partially slagged outer surface, (2) a white-colored zone completely vitrified and containing small crystals of mullite, (3) the general body of the pot which shows a progressive development of mullite toward the inside and outside of the pot, (4) a white porcelainlike layer containing mullite crystals in a glassy matrix, and (5) a clear glassy layer containing mullite and corundum along the junction with the previous layer. Closer study shows that zone (4) above really consists of 3 layers. In the region next to the pot body there is an excess of alumina and very little absorbed alkalis and lime from the glass so that there is oversaturation with alumina which combines with the silica to form abundant crystals of mullite. In the central region there is absorbed glass

and no excess of alumina but as the melt is just saturated with it the needlelike mullite crystals which float off from the first-mentioned layer are not dissolved. The third region is the one in contact with the molten glass. Mullite crystals which float into it are dissolved. The durability of the pot depends on the balance between the rates of formation and of solution of the mullite layer. In siliceous clays this layer is very thin and its protective action is much reduced. It would seem from this that only aluminous clays should be used. The siliceous clays, however, have greater mechanical strength at high temperatures and with highly aluminous pot clays there is a tendency for the glass to become stringy as the alumina-rich layer of glass is drawn into the body of the glass as the pot is worked out; hence, a compromise between the aluminous and siliceous clays is desirable. It is noticeable that pot mixtures containing as high as 60% natural sillimanite do not show the latter disadvantage and are also free from the excessive shrinkage which is characteristic of high alumina clays. The size and character of the grog used in the pot mixture is an important factor in the resistance to mechanical erosion by the flow of molten glass. The grog should be hard fired so that it crushes into angular fragments. In general, $^1/_8$- to $^1/_{16}$-inch grog gives the best results although finer grog gives better service in the case of lead glasses. For previous articles on this subject see *Ceram. Abs.*, **7** [5], 302; [6], 372 (1928). A.J.M.

Mullite refractories extend field of high temperature processes. W. A. KOEHLER. *Chem. Met. Eng.*, **35,** 86–88 (1928).—A comprehensive discussion of mullite and its formation from sillimanite, cyanite, and andalusite, all of which decompose spontaneously into mullite when heated. Cyanite and andalusite expand during this conversion to such an extent that it is necessary to calcine them before making them into shapes. In making shapes, the mullite is usually bonded with plastic kaolin, although some manufacturers are making brick without a foreign bond, depending on recrystallization of the mullite grains for cohesion. The Corning Glass Company is now casting blocks from molten material for glass tank blocks. These blocks must be cast to exact dimensions, as their hardness prevents chipping. Their porosity is zero, and the rate of corrosion is only about one-third that of fireclay blocks. M.E.M.

Vitrification of ceramic bodies. ANON. Bur. Stand., *Tech. News Bull.*, No. 133, 70–71 (1928).—An investigation of the boundary of the field of mullite in the K_2O–Al_2O_3–SiO_2 system is being made. Minerals are mostly used in making melts. Minerals are mixed in proper proportions with dextrin and extruded from a glass tube. The mixture is then melted, quenched, and examined microscopically. Melts containing varying amounts of orthoclase, kaolin, and flint were made. Mullite crystals were found to occur in melts containing at least 30% kaolin, those with less containing mostly glass. There is an almost constant variation in the indices of the glasses ranging from 1.48 with 10% kaolin to 1.54 with 90%. The amount of mullite increases with the index of the glass. Leucite-kaolin melts show practically the same results as do orthoclase-kaolin melts. R.A.H.

Refractories papers read at Ceramic Society. ANON. *Pottery Gaz.*, **53** [612], 949–52 (1928).—The Refractories Materials Section of The Ceramic Society visited the Cornish china clay mines of the H. D. Pochin & Co., Ltd. At the technical session papers were read as follows: (1) "Refractory Mortars," by D. A. Moulton; (2) "The Effect of Substituting High Silica Sand for Some Grades in Lime-bonded Silica Brick," by W. Hugill and W. J. Rees; (3) "The Part Played by Refractories in Connection with Recent Developments in Gas-works Carbonization," by G. M. Gill; and (4) "The Vitrification of Clay Products," by A. T. Green.

Refractories and the chemist. ARTHUR DUCKHAM. *Chem. and Ind.*, **47,** 552 (1928).—Attention is called to the need for satisfactory refractory materials with good jointing and patching cements to meet all temperature conditions, and to resist the chemical

action in the vessel or other apparatus. Although there have been marked improvements during the past few years, much remains to be done. The use of high grade silica in construction has led to greatly improved results, with a consequent increased demand for silica. The chemist's tools in determining the requirements of satisfactory refractories have been specific gravity and expansion, fusion temperature, and the study of structure by microscope and macro-section. H.H.S.

Fireclay deposits of Saskatchewan. G. M. HUTT. *Power Age*, May, 37–38 (1928). —The Canadian Pacific Railway through its development branch is in association with the Dominion and Saskatchewan Governments and the Univ. of Sask. to develop the several areas of important deposits of refractory and related clays in southwestern Saskatchewan. From the viewpoint of railway facilities, there are 3 main areas, *viz.*, The Cypress Hills, the Valley of Lake-of-the-River, and Claybank. (1) yields a good stoneware clay suitable for bodies firing at cones 5–9; (2) ball clay or semichina, with some clays approaching No. 1 grade of refractoriness; (3) used for fire brick and locomotive tile. A steady increase of U. S. purchases of Saskatchewan clays is noted. H.H.S.

BOOK

National Physical Laboratory Report for 1927. Published by H. M. Stationery Office, Dept. Sci. and Ind. Res., London. The progress of the investigations in the following departments of the Laboratory are reported: (1) physics, (2) electricity, (3) metrology, (4) aerodynamics, and (5) metallurgy. The work on special refractories is of interest, the key to success being in the selection and production of a satisfactory container for the metal when molten or under treatment at high temperatures. It is only by the use of these special refractories that it has been possible to achieve the high degree of purity which is possible in the preparation of certain of the metals. The high temperatures involved, especially under reducing conditions, and the necessity for maintaining high purity in the molten material, make stringent demands on crucible refractories, and efforts are continually being made to produce more satisfactory materials. Crucibles of pure magnesia and alumina undergo reduction under certain conditions of melting, and attention is being directed to other refractories which may prove to be less readily reduced. Some crucibles of pure thoria have been prepared, which have been successful for the melting of pure iron and are now being tested for use with other metals and alloys. One of the recent developments in the production of special refractories consists in the evolution of a process whereby nonplastic materials may be extruded in the form of tube and rod by incorporating with them a suitable organic binder or "dope" such as cellulose acetate solution. The success of this process has rendered it desirable to utilize the extrusion method of the production of articles of much larger diameter than have formerly been produced in that manner in the Laboratory. A larger extrusion machine has therefore been designed and is at present under construction. It is hoped to produce muffles and other articles from nonplastic materials by the use of this machine. F.P.H.

PATENTS

Making X-ray anodes. EMERY G. GILSON. U. S. 1,671,953, May 29, 1928. The method of making an electrode of refractory material which comprises surrounding one end of a metal stem with refractory material, and simultaneously applying heat and pressure to the refractory material.

Refractory material. JOSEPH G. DONALDSON AND HENRY L. COLES. U. S. 1,673,106, June 12, 1928. A refractory article composed of nearly 70% zirconium oxide, less than 30% zirconium silicate, and carbon, the carbon being dissolved in the silicate.

Refractory material. JOSEPH G. DONALDSON AND HENRY L. COLES. U. S. 1,673,107, June 12, 1928. A refractory material comprising more than 85% zirconium dioxide, less than 15% silicon dioxide, and less than 10% carbon, the carbon being dissolved in the silicate formed during fusing of the oxides.

Refractory substances. A. WAGEMANN. Brit. 286,677, May 2, 1928. The strength of refractory substances of the kind comprising claybound quartz, sand, chamotte, and siliceous material is increased by the addition of a small percentage (up to 10%) of artificial silicates containing alumina, such as slag, in a very fine or colloidal state.

Sand molds. BRITISH MAXIUM. Brit. 287,164, May 9, 1928. To protect magnesium, its alloys, or other easily oxidizable metal when cast into a sand mold salts of ammonium are mixed with the sand or applied, wet or dry, to the inner surface of the mold. For instance, 2% of ammonium borate or fluoride may be mixed with the sand, the fluoride producing a protective film on the casting. Agglomerants, solutions of resins in oils, or other substances more easily oxidizable than magnesium may also be added to the sand.

Furnaces. GENERAL ELECTRIC CO., LTD. Brit. 288,668, June 7, 1928. In a tank furnace for glass manufacture built up of refractory blocks, the latter are formed with one face inclined to a horizontal base and are assembled so that their inclined faces form the inner walls of the tank. The construction of tank furnaces for the manufacture of light and heavy glasses respectively is described, the side walls being, in the former case, inclined outwardly and in the latter case, inwardly. In both constructions the lower parts of the walls adjacent the floors are vertical.

Terra Cotta

Raw yellow glazes for terra cotta and development phenomena. L. R. SQUIER. *Jour. Amer. Ceram. Soc.*, **11** [7], 584–86 (1928).—A study made for the purpose of developing raw yellow colors for terra cotta, using two glaze bases with rutile, barium chromate, and uranium oxide, introduced as sodium uranate, is described. Results obtained and development phenomena observed are discussed.

PATENT

Preformed acoustic unit. MAURICE C. AND STANLEY H. ROSENBLATT. U. S. 1,671,208, May 29, 1928. The combination with a surface to be treated of a plurality of acoustic units associated therewith in abutting relation, each unit comprising a backing board, a felt layer and a membrane, and means engaged between the surface and the backing board for positioning each unit.

White Wares

The requisite consistency for a casting slip. WALTER L. SHEARER. *Jour. Amer. Ceram. Soc.*, **11** [7], 542–59 (1928).—Producing desirable flowing quality in a slip is proposed as a means of controlling its casting quality. A conception of plastic flow as a property incapable of being measured in terms of an absolute unit such as may be applied to viscosity measurement is presented and a simple gravity flow tube consistometer of suitable dimensions for obtaining comparative tests upon casting slips or upon similar suspensions is described. Only sufficient data are presented to aid in explaining or describing general principles or conceptions, to suggest means of obtaining desirable plastic flow and to show what the consistency of a vitreous sanitary ware casting slip now in use actually is. Stiffness, yield value, and starting pressure are regarded as the elements making up plastic flowing quality and it is necessary to take all three of these factors into account in order to specify the kind of flow obtained.

The consistency of a casting slip which will produce good solid cast ware, described in terms of the test apparatus used in connection with this work, may be stated as follows: stiffness equals 60 cm. per cc. per sec.; yield value equals 20 cm.; plasticity ratio equals 2.5. Reference has also been made to the application of these same principles to the control of glaze slips and to the testing of clays to determine their suitability for use in any process involving their plastic working properties.

Chemical control of feldspars. F. P. KNIGHT, JR. *Jour. Amer. Ceram. Soc.*, **11** [7], 560–70 (1928).—A definition of feldspar is given. Minerals in feldspars are enumerated. The importance of chemical control, method of analysis, and calculation of mineral composition from chemical analysis are taken up. A discussion of the value of the calculation is presented. In explaining mechanical control procedures, method of sampling, storage and mixing of feldspars, fusion test, block test, reasons for the non-uniformity in fusions, and free quartz determinations are described and discussed.

The effect of arcs on high tension insulators. K. DRAEGER. *Elek. Zeits.*, **49** [21], 785–89 (1928).—Porcelain insulators are probably sufficiently high in puncture strength so that failure is not caused in service by punctures at normal voltages but by thermal changes from arcs or from induced surges caused either by switching mechanism or by lightning impulses. There are four types of power arc failures considered: (1) conduction over dirty surface building up current until real power arc takes place or slow heating from a small amount of current; (2) clean insulators arcing over due to lightning or switch surges followed by power current; (3) short-circuiting of insulators due to foreign bodies; and (4) direct lightning hits. Experiments are set up to duplicate these first three conditions. Measurements are made by means of an oscillograph of the current and voltage in the arc and the time of the arc. Tests are made on suspension insulators of the motor type carrying load of 1000 kg. The arc currents vary from 147 to 1250 amperes and the duration of the arcs were from 0.8 to 4.2 seconds. It is concluded that the material of the porcelain body and the shape of the metal cap had considerable effect on the resistance of the insulator. The cap advised was of a type having no heavy ring around the bottom but a straight cylindrical cap tending to make the arc play over its surface and not concentrate on one point. A current of 600 to 700 amperes was found to be the most destructive current since this type of current holds more tightly to the surface of the insulator. Lower current arcs played around at different places on the insulator string and higher currents bent the arc away from the string. Arcing horns and rings were not found to have any effect on the arc. Direct lightning strokes are thought to be purely mechanical in action. Photographs of insulators broken by lightning strokes on dead lines did not show any burning of the porcelain or hardware and the type of fracture was similar to a mechanical break.

J.T.L., JR.

Wall tile (essentially from clay). ANON. *Ceram. Age*, **11** [5], 180–82 (1928).—It is pointed out that fired clay products have reasonable claim to exclusive use of the word "tile." "What Is Tile?" by D. P. Forst is given. F. protests against the use of the phrase "a perfect porcelain tiled wall finish" and the trade name "Porstelain" in connection with enameled steel products which have recently appeared on the market. F. claims that fired clay tile have exclusive right to the name "tile" and gives historical and other reasons. The exclusive qualities of clay are listed. The modern tendency toward the misuse and confusion of names is deplored and the wisdom of the policy of introducing new products under old names questioned. The latter practice is considered unprofitable except when inferior products are being sold. A.E.R.W.

"Blanc de Rouziganet" deposit. R. LEDUC. *La Céramique*, **30** [470], 73–77 (1927).—L. describes the geology, stratigraphy, and structure of the deposit of "blanc de Rouziganet," a siliceous material which has been used for a long time in the manufacture

of pottery and other ceramic materials. A detailed report is then given of an investigation of the chemical and mineralogical character of this material. From mechanical analyses, colloidal studies, and chemical analyses it is concluded that lime is the principal vitrification agent in the "blanc" and that vitrification takes place readily because of colloidal silica which constitutes 15% of the residue from levigation. The drying and firing properties of the "blanc" were determined. The combined linear drying and firing shrinkage at 1400°C was 2.5%; at 1500, 1.8%; and at 1600, 1.4%. L. discusses its use in rammed refractory linings. A chemical analysis of the material follows:

Ignition loss	Free Al_2O_3	Al_2O_3	SiO_2	Fe_2O_3	CaO	MgO	TiO_2	Alkalis
2.70	0	6.55	87.50	1.20	1.25	trace	0	0

A.E.R.W.

Tests of sagger bodies. H. KOHL AND E. KIEFFER. *Ber. deut. keram. Ges.*, **9** [2], 57–69 (1928).—Three sagger bodies were investigated: (1) a body containing a sandy clay, a washed kaolin, and fine grog, (2) a body containing a sandy clay and the same grog as in (1), (3) a body containing the same clay as in (2) but coarser grog The following physical tests were carried out on the 3 bodies: (*a*) sieve analyses of the air-dried body mix, (*b*) water absorption of bodies fired to cones 1a and 7, (*c*) load test on the fired bodies, (*d*) expansion curve for the bodies over the temperature interval 20–600°C. Saggers were made of these three bodies and put in use in the plant. There was not very much difference in the life of saggers made of these mixes except that (1) and (3) gave somewhat greater service than (2). The prime condition to be met in considering the life of saggers is the ability of the body to withstand sudden temperature changes. F.P.H.

Whiteware manufacturers meet. ANON. *Ceram. Ind.*, **10** [6], 641 (1928); see also *Bull. Amer. Ceram. Soc.*, **7** [7], 223 (1928). F.P.H.

Winning kaolin from a Florida deposit. C. W. HALL. *Ceram. Ind.*, **10** [6], 662–64 (1928).—In occurrence and composition Florida clay is similar to the white kaolin produced in Ga. and S. Car. except that natural impurities such as sand and organic material in Florida clay necessitate a washing treatment for preparation. The nature of the formation and necessary method of refining the product introduces problems and expenses in production that are disparate to the kaolin fields farther north. Florida kaolin is now being produced in two different localities within the state, namely, Putman and Lake Counties. The clay produced is used almost exclusively in the whiteware industries, principally for making pottery, floor and wall tile, decorative tile, spark plugs, electrical porcelain, and for floating glaze materials of non-plastic nature, also enamels and engobes. The clay as mined varies in color from gray to snow white, and consists of a large part of sand, and some mica (muscovite); both impurities are rejected in the treatment plant. The component body (clay, sand, and mica) has an average specific gravity of 2.45. The clay is plastic and extremely sticky when wet. The dried product is somewhat unctuous in feel. The clay particles are finely divided, practically all passing a 300-mesh screen. A chemical analysis of the washed clay follows: SiO_2 45.65, Al_2O_3 38.62, Fe_2O_3 0.40, CaO 0.40, MgO 0.25, Na_2O, K_2O 0.47, TiO_2 0.18, H_2O 14.95. The mining and refining of the clay are described. F.P.H.

Mechanical test methods for high-tension insulators. RUDOLF PFEIFFER. *Keramos*, **7** [6], T3 (1928).—A method of testing the resistance of an assembled insulator to the constant vibration that it is subjected to while in use is described. The insulator is subjected to three types of vibration, namely: (1) vibration along the axis of the insulator, (2) vibration at right angles to the axis, and (3) torsional vibration. An apparatus for carrying out this test is described and illustrated. F.P.H.

The color of clays and its cause. ANON. *Master Builder*, [787], 67 (1927); *Tonind. Ztg.*, **52** [12], 219 (1928). F.P.H.

Chelsea china. A. HAYDEN. *Illust. London News*, **172,** 861 (1928).—The factory, of which it is said that no English porcelain factory has ever equaled its production between 1750 and 1764, came into being in 1744. Many of the ground-colors used at Chelsea were original, such as the *gros-bleu* and the claret which were adopted by Sèvres and Meissen. Sprimont's experiments show almost the exact dates when new formulas were introduced. In 1769, the plant was purchased by W. Duesbury of the Derby factory. He ran the two factories from 1770 to 1784 (the period known as Chelsea-Derby) and razed the buildings at Chelsea. H.H.S.

PATENTS

Pin for insulators. JOHN PHILIP ARNDT. U. S. 1,670,429, May 22, 1928. An insulator pin comprising a pair of sheet metal members having coöperating insulator-receiving ends and spaced at their other ends and at intermediate portions for engagement with opposite sides of a cross-arm, and spaced parallel clamping bolts connecting the members together with the cross-arm between the bolts, there being aligned openings in the members for one of the bolts permitting the placement of the bolt at any one of a plurality of predetermined positions varying in distance from the other of the bolts to accommodate cross-arms of different sizes.

Spark plug. JOHN ROY BALDWIN, JR. AND ROBERT WALTER SCHAEFER. U. S. 1,671,268, May 29, 1928. A spark plug comprising a hollow cylindrical body with one end open and exteriorly threaded to seat in the cylinder head of an internal combustion engine, and with the other end interiorly threaded and normally sealed with a removably secured insulator plug, and with the portion intermediate the threadings of its ends enlarged and provided interiorly with a sparking chamber communicating with the cylinder through the open body end, the combination therewith of an electrode positioned within the sparking chamber axially secured within the insulator plug and exteriorly adapted to connect with a source of electric current, a co-acting electrode adjacent the first-mentioned electrode and secured to the inner wall of the body, an intermediate portion of the body adjacent the sparking chamber exteriorly threaded and provided with diametrically opposed ports located opposite the electrodes to provide a straight passage through the body and the sparking chamber and adapted for insertion and passage through the chamber of tools, abrasive cloth or the like for cleaning the electrodes, and a removable nut fitting upon the exteriorly threaded intermediate body portion and adapted to expose the tool ports during the cleaning process and to seal them during explosion.

Insulator. WILLIAM S. COOK. U. S. 1,672,059, June 5, 1928. (1) A two-part insulator of the class described comprising coöperating respectively projecting and recessed parts secured together by lining and covering the walls of both parts with an elastic cement there being provided intervening bodies of hard cement and longitudinally spaced bodies of elastic cement interspersed therebetween. (2) A method of assembling two part insulators of the character described which comprises coating the walls of coöperating projecting and recessed parts with an elastic adhesive and then pouring into the space between the walls alternate bodies of hard and of elastic cement.

Making finely perforated ceramic plates. JOHANN FRIEDRICH SCHEID. U. S. 1,673,269, June 12, 1928. Method of making finely perforated ceramic plates, consisting in this that a plate of ceramic material is molded, holes stuck into the plate which do not entirely traverse the plate, then the plate hardened, and finally the part of the plate not traversed by the holes removed.

Spark plugs. M. SCHNEIDER. Brit. 287,068, May 2, 1928. An insulating member separate from the main insulator is formed with a number of projecting ribs, and is retained in position by the nut on the central conductor which draws an abutment

against a shoulder on the member. An externally grooved metal collar separates the shoulders on the two insulators. Washers are also interposed.

Molding pottery. W. J. MILLER. Brit. 287,083, May 9, 1928. Plastic material is forced in measured charges by a reciprocating plunger through a chambered profile into or on to a mold. Containers furnished with feed pumps equipped with blades, are fitted with extensions forming profiles. Plungers working in chambers force the material through openings and excess material returns to the containers through openings leading to chambers fitted with spring-retained valves. Each plunger is adjustably carried by a lever adapted to be raised by a cam on a shaft and depressed by a spring, the descent being regulated by a stop screw. The molds are carried by spindles adapted to be raised by forks carried by rods connected to levers having rollers engaging cams on shafts and to be rotated through friction gear. When the spindles are lowered, the rotation is stopped by brake members raised by levers operated through rods by cams on the shaft. The molds are supported by trays connected by trunnions to a chain conveyer and are advanced intermittently by a pawl on a lever operated by a cam on the shaft. Motion is imparted to the shaft through chains and the shaft is driven through bevel gearing. The charge of material is lubricated by water supplied by a pipe fitted with a hand valve and supplied through a valve controlled by a cam on the shaft, or by a pump, having a piston operated by a cam on the shaft against the action of a spring, the stroke being regulated by a screwed sleeve. Instead of returning direct to the container, excess material may pass to a receptacle, via a chamber and valve and be reconditioned before its return to the container. The chamber is furnished with a baffle and is connected to a vacuum. Modifications are shown including a deep profile. To prevent spreading, the material is retained by a guard. Another modification has a horizontally-disposed container pivotally supported and movable, with the profile by a handle, the extent of movement being limited by stops on a rod. The feed shaft is rotatable continuously by a motor or intermittently by a pair of oppositely-disposed ratchet-bars. The plunger is operated by a lever and its movement is limited by a screw. The brake disk is normally engaged with the disk by a rod forced upwardly by a spring and adapted to be depressed by a pedal lever.

Spark plugs. H. DE RUYTER. Brit. 287,107, May 9, 1928. The central conductor is made in two parts, separated by a spring. The inner portion is enclosed in insulating members retained by a collar and head. A shoulder within the threaded end of the casing provides a seating for the insulator, while the insulator and head are lodged within the lower end of concentric sleeves, the inner sleeve being of insulating material. An annular space into which air may pass through apertures separates the sleeve from the outer casing. Inclined shoulders with sharp edges which penetrate the adjoining surfaces, form gas-tight joints within and without the base of the sleeve. The outer part of the central conductor is removable and is mounted within wrappings and washers of insulating material and a gland. Within the upper ends of the sleeves, washers, packing, and a gland are held by the main gland which engages the casing while the gland serves to retain the member and its associated parts.

Artificial teeth. HILTEBRANDT ZAHNFABRIK AKT.-GES. Brit. 288,200, May 31, 1928. In order to prevent the metal backing plate from showing through the comparatively thin cutting edge of a porcelain tooth, the latter is provided on its back surface with a layer of nontransparent material, preferably a nontransparent porcelain mass harder than that used for the facing and such as to acquire a smooth polished surface when fired. The mass extends at least up to the fastening pins and preferably up to the neck of the tooth.

Molding earthenware. A. HANDLEY. Brit. 288,355, May 31, 1928. Apparatus for molding teapot lids, etc., comprises a one-piece female die adapted to form the major

portion of the cover and a pair of split dies adapted to form the neck and locating-flange. The female die is supported upon a block on which are slidably mounted a pair of carriers carrying upper and lower half dies. The carriers are forced together by cams mounted upon the press columns and interconnected through levers and an adjustable link. Springs force the carriers apart upon release of the cams. A central die forms the knob and is operable by treadle gear to eject the molded lid. The die slides upon a stationary perforating-rod adapted to enter an aperture in the pressing die. In operation the cams are operated by a handle to close the mold after which a charge of material is introduced and the die levered by a screw to press the material; the die is then withdrawn and the mold opened, after which the lid is ejected by the die. The split dies are operated by eccentrics and the pressing die is fitted with a spring air-valve.

Glazes. J. W. MELLOR. Brit. 288,679, June 7, 1928. A leadless or practically leadless glaze for use in the manufacture of ceramic ware consists of approximately two parts of Cornish stone or its equivalent and one part of borocalcite or an insoluble or very slightly soluble calcium borate. One or more or the following substances may also be added: whiting, cryolite or fluorspar, china clay. Sodium silicate, ground flint, or ground sand may also be introduced into the glaze together with a pigment or opacifying agent such as tin oxide. For each part of borocalcite or calcium borate in the glaze, the proportion of Cornish stone may vary from $1^3/_4$ parts to $2^1/_4$ parts. The glaze may contain a small quantity of a lead compound such as lead silicate.

Wall and floor tile. A. FEIST AND F. L. KOPP. Brit. 288,867, June 7, 1928. Cold-glazed wall or floor tile or slabs are formed by mixing burnt magnesite, fine sand, pulverized talc, and a pigment, adding magnesium chloride lye and stirring to obtain a pasty mass, then kneading with a hardening material, such as a mixture of known kind containing bituminous substances and silico-fluorides, and allowing the mass to set in molds preferably having a glass or celluloid base. A mixture of 3 liters of magnesite, 5 liters of white quartz sand, 2 of gravel or terrazzo, $^1/_2$ of pulverized talc, and $^1/_4$ to $^1/_2$ of oxide pigment has added to it sufficient magnesium chloride lye of 20–24° Bé to yield a pasty mass, and is then kneaded with $2^1/_2$–3 deciliters of the hardening material.

Equipment and Apparatus

A mercury vapor trap of low resistance. THOMAS H. JOHNSON. *Jour. Franklin Inst.*, **205**, 99–101 (1928).—It is shown that the ordinary mercury vapor trap inserted in pumping systems for high vacuum may actually decrease the speed of exhaustion. A type of trap using liquid air is shown in a sketch which tests have proved to function so as not to reduce speed materially and to give a mercury vapor pressure of less than 10^{-6} mm. The mercury coating which forms on the side walls of the trap acts as a radiation shield so that liquid air will remain in the pump for three or four hours without replenishing. J.T.L., JR.

Continuous kiln for firing pottery and other clay products. J. WILLIAMSON. *Ceram. Age*, **11** [5], 182–85 (1928).—Reprinted from *Brit. Clayworker*.

Experimental studies, French Society of Ceramic Manufacturers. V. BODIN AND P. GAILLARD. *La Céramique*, **30** [473], 150–59 (1927).—A tabular summary is given of the information obtained from an inspection of kilns carried out by the technical-service of the Society during 1926. In each table the dimensions and arrangement of zones in the kilns are shown by diagrams. All the kilns are of the continuous type, consisting either of two parallel galleries with ducts across the ends or of chambers arranged in zig-zag fashion. A complete tabulation of the construction and operating characteristics of 29 kilns is given. The data given include (1) density of setting, (2) initial moisture content of ware, (3) dimensions of kiln and chimney, (4) draft, (5) fire-travel rate, (6) length of zones, (7) daily production, (8) production per sq. m.

cross-section, (9) temperatures, (10) CO_2 content of flue gases, (11) volume of "parasitic" air, (12) coal consumption, and (13) analysis and calorific value of fuel. Kilns with artificial draft and automatic fuel chargers are of special interest. In one kiln, speeding up of the rate of fire-travel and using a less dense setting increased production greatly. Comparison with previous reports is made. Periodic inspections and investigations of optimum fire-travel and minimum soaking are suggested. Conditions necessary for satisfactory kiln operation are listed. A long discussion follows the paper.
A.E.R.W.

Conveyers for the reduction of production costs. WENZ. *Ber. deut. keram. Ges.*, **9** [2], 34–56 (1928).—The various forms of conveyers applicable to different stages of the various ceramic processes are described and fully illustrated. The advantages of the different types of conveyers are pointed out. F.P.H.

The use of Seger cones to control firing in ceramic kilns. R. RIEKE. *Ber. deut. keram. Ges.*, **9** [2], 78–83 (1928).—Seger cones do not measure temperature in the same sense as the thermo-element or optical pyrometers do, but measure the heat treatment that a body has undergone. The advantages and disadvantages of the cones are discussed and an excellent bibliography covering the subject for the last 20 years is given.
F.P.H.

Style and application of electrical pyrometer. FRIEDRICH DETTMER. *Ber. deut. keram. Ges.*, **9** [2], 83–107 (1928).—The following types of pyrometers are described and illustrated: (1) resistance, (2) thermo-electric, (3) optical, (4) light-radiation, (5) heat-radiation. The limitations of these various pyrometers are discussed. Information concerning the following factors pertaining to the use of thermo-elements is given: (1) composition of the elements, (2) type of protection for the elements, (3) useful range, (4) upper temperature limit of the two elements, (5) effect of various furnace gases, etc., on the elements, (6) the proper installation of the thermo-elements.
F.P.H.

Starting alternating current motors. C. W. FALLS. *Blast Fur. Steel Plant*, **16** [3], 385–89 (1928).—Methods of starting squirrel cage induction and synchronous motors are reviewed as affecting driven machinery, power supply, and the starting and motor equipment. F.P.H.

Installing centrifugal pumps. JOHN H. JONES. *Blast Fur. Steel Plant*, **16** [5], 649 (1928).—A practical discussion pointing out the correct procedure in installing and operating centrifugal pumps to secure efficient and satisfactory service. F.P.H.

X-rays in ceramics. T. N. MCVAY. *Brick Clay Rec.*, **72** [12], 845 (1928); *Ceram. Ind.*, **10** [6], 629 (1928).—With the X-ray it is possible to examine particles as small as 1/50,000,000 of an inch or smaller. The applications may be divided into 2 classifications: (1) the study of the fine structure to determine the mineralogical character, and (2) the study of the orientation of the grains which gives the material directional properties or fibering and through the analysis of fibering the determination of internal strain. The changes taking place in clays during firing is a particularly important field of fundamental investigation and positive results are obtained by X-ray examination. A search of the literature reveals only two clays which have been rather thoroughly investigated by X-ray methods. The changes taking place in porcelains have been investigated by Krause in Germany, who worked with only one body. Within the last few years studies have been made of the fit of the glaze and the body by determining the thermal expansion of the glaze and body at different temperatures and thus finding a glaze which had approximately the same expansion as the body. It is possible that these strains can be determined by exposing a section of the glaze and the body to the X-rays. It is also possible that strains developed during drying can be examined in a similar manner. K. reports that there is a definite orientation of the clay particles in

drawing out a rod of plastic clay. This probably explains the differences in the linear drying shrinkages in different directions in ceramic bodies. Also, he found that the clay particles definitely oriented themselves when dry pressed. F.P.H.

Measurement of percussion. JULIUS OELSCHLÄGER. *Keramos*, **7** [6], T6 (1928).—For the measurement of percussion or shock the following equipment is required: (1) a seismograph, (2) a vibration indicator, (3) a vibration recorder. The above equipment is described and illustrated and its use is discussed. F.P.H.

Internal-type vacuum filter. J. T. SHIMMIN. *Min. and Met.*, **9** [257], 227–29 (1928).—There has been steady advancement in the art of vacuum filteration for twenty-five years; today its use has become virtually standard practice for dewatering throughout the entire metallurgical industry as well as in important parts of the chemical and industrial processing fields. In filtration practice (a fact recognized by the pioneers in the field) a certain amount of the fine material is essential in order to dewater coarse particles, these fines forming a binder to make the coarse material adhere to the filter medium. The segregation of coarse particles is also greatly influenced by the viscosity of the pulp undergoing filtration which, in turn, is a function of percentage of moisture. The first Shimmin filter was 14 ft. in diameter, with a 14 ft. wide face, and handled over 500 tons of copper concentrate in 24 hrs. The drum was cylindrical in shape, entirely closed at one end and open at the other end, with the exception of an internal flange about 3 ft. wide. The filter medium was applied on the inside of the drum, being divided into panels by the strips which secured it in place. The pulp to be filtered was fed into the drum through the open end, being retained inside by the dam formed at the open end by the internal flange. This construction eliminated the troublesome filter-tank, as the drum acted as its own pulp container. The mechanical features were quite simple. The drum was rotated by a worm and worm-gear driven through a speed reducer connected to a motor. A trunnion bearing supported the drum at the closed end while the drum was supported near the open end by a trundle, the tire of which was bolted to the filter shell and carried on rollers mounted on a base. Vacuum for cake formation and air for cake discharge were admitted to the panels by pipes attached to the outside of the shell and connected to a rotary port-valve on the main shaft. The cake was discharged into a hopper within the drum and removed by a belt conveyer. F.P.H.

Metering of air, gas, steam, and liquids. J. L. HODGSON. *Glass*, **4** [12], 532 (1927).—The metering of fluids is important for the following reasons: (1) enables the output or the intake of a plant or of a machine to be checked against guarantees; (2) enables inefficiency in a plant or machine to be detected and remedied; (3) aids in controlling processes in which it is necessary that the fluids should be supplied at a given rate; (4) enables valuable fluids such as gas, compressed air, hot or cold water, and steam to be sold or apportioned to departments according to the quantity actually consumed; and (5) ascertains the minimum amount of fluid required for the efficient production of any given output. Detailed descriptions of the shunt-type rotary steam-meter, the shunt-type rotary air-meter, and the gate-type air recorder are given. (Illustrated). A.J.M.

Sand settling and devices for settling and classifying sand. IV. EDMUND SHAW. *Rock Prod.*, **31** [9], 48–49 (1928).—The calculations necessary to design rising current classifiers are considered. **V.** *Ibid.*, [11], 39–43 (1928).—The automatic settling tank is discussed. For preceding abstracts see *Ceram. Abs.*, **7** [6], 385; [7], 453 (1928). F.P.H.

The Instrument World. London: 72–78 Fleet Street, E.C. 4. Price 6 pence monthly. Intended for designers, makers, vendors, and users of scientific instruments, the new journal will enable these different sections to maintain beneficial contact. The

first number contains articles on instruments in industrial research, the electric furnace as a scientific instrument, and inexpensive spectrometric apparatus, and the first installment of a glossary of technological terms applied to instruments, as well as reviews of books and recent instruments, notes on patents, etc. H.H.S.

A new filter system for the chemical industry (deposit filter process). K. KELLER. *Chem. Ztg.*, **52,** 111–13 (1928).—The Seitz filter is designed for removing extremely small particles by mixing the solution to be filtered with specially prepared asbestos fiber and passing into the closed filter body where it is deposited on special cells with wire gauze sides. The asbestos may be mixed with other fibers to alter the rate of filtering. (*C. A.*)

The thermogalactometer. A. BARDISIAN. *Pediatria Rivista*, **35,** 1118 (1927).—Good results were obtained with the apparatus which is to replace the calorimeter for the determination of caloric value. The combustion is carried out with H_2SO_4 and the temperature measured with a thermometer. (*C. A.*)

Dispersing machines: colloid mills and emulsifiers. J. H. FRYDLENDER. *Rev. prod. chim.*, **31,** 81–88, 121–28 (1928).—A description of the various machines at present on the market, and of their applications. (*C. A.*)

PATENTS

Rotary pump, motor, and meter. RUDOLF HAAS. U. S. 1,670,681, May 22, 1928. A machine of the worm and worm wheel type, comprising in combination a casing having a low pressure and a high pressure chamber, a worm in the casing, a wheel chamber provided on the casing, a worm wheel in the wheel chamber, the worm wheel being adapted to coact with the worm, a small passage for establishing restricted communication between the wheel chamber and the high pressure chamber and a large passage for establishing free communication between the wheel chamber and the low pressure chamber, as and for the purposes set forth.

Psychrometer. EMIL J. CARROLL AND GEORGE W. JOHNSON. U. S. 1,671,103, May 29, 1928. A psychrometric instrument, comprising dry and wet bulb thermometers, two electric circuits, and means controlled by the thermometers for producing a changed condition in one of the circuits when the relative humidity reaches a predetermined maximum ratio and in the other of the circuits when the relative humidity reaches a predetermined minimum ratio, the means including variable means adapted by variation thereof to produce the changed condition in the circuits when the relative humidity reaches any desired predetermined maximum and minimum ratios.

Moist-air flue for drying machines. FRANK L. FURBUSH. U. S. 1,671,523, May 29, 1928. In a drier, the combination with an endless apron for conveying the material throughout the length of the machine and a series of partitions for driving the drier into a plurality of compartments, of blowing means at one side for circulating the air down through the material on the apron, a series of heating coils in each compartment on the same side as the blowing means through which the air is circulated thereby, and a moist air box located between each two adjacent sets of coils for receiving the air directly from the bottom of the drier below the coils and exhausting it into the open air.

Automatic temperature regulator. JEAN V. GIESLER. U. S. 1,671,525, May 29, 1928. In a temperature regulating apparatus, in combination with means for regulating the supply of heat, a thermostat for operating the means over a wide range of temperatures, a lever provided with an adjustable weight for predetermining the temperatures at which the thermostat may operate the means, and motive means for moving the weight along the lever to progressively vary the temperature at which the thermostat may operate the means.

Pyrometer. ROBERT C. PAIRMAN. U. S. 1,672,229, June 5, 1928. A device comprising an elongated tube construction of a substantially nonexpandible metal, a plug

forming a closure for one end of the tube, the opposite end of the tube being open, a rod insertible in the tube and resting on the plug, the rod being constructed of an expansible metal and being freely expandible within the tube, a plunger member insertible in the open end of the tube and resting on the expandible rod, the plunger member having a collar formed thereon and disposed below the open end of the tube to form a cover therefor to prevent admission of dust, a flat substantially triangular plate supported by the tube and having a graduated scale thereon, an indicator arm pivotally mounted on the plate and movable with relation to the graduated scale on the plate, and means for transmitting movement from the plunger to the indicator arm.

Rotary pump. LEONARD F. HEITZ. U. S. 1,672,257, June 5, 1928. A device of the character described, comprising a casing having a cylindrical chamber with a suction port and a discharge port, a rotor in the chamber having a concentric series of laterally extending spaced teeth operatively adjacent the cylindrical wall of the chamber, a rotatably mounted idler positioned within the series of rotor teeth in eccentric relation thereto, the idler having radial teeth engaging the series of rotor teeth between the ports, the idler teeth being of greater width than the lateral length of the rotor teeth, a stationary crescentic member occupying the space between the paths of movement of the idler teeth and the rotor teeth in their disengaged relation, and an end closure for the chamber, the end closure having that portion of its inner face opposed to the idler and between the ports in a plane with the adjacent side of the idler, and having that portion of its inner face opposed to the path of movement of the rotor teeth when out of engagement with the idler in a plane with the adjacent ends of the rotor teeth.

Thermostat. HUBERT R. LORANGER AND DALLAS D. PARSHALL. U. S. 1,673,255, June 12, 1928. A thermostat comprising an expansible chamber and a housing within which the expansible chamber is located, the walls of the housing having a relatively high coefficient of heat transmission and being constructed and arranged to function as a holdover.

Eccentric mechanism for separators. THOMAS J. STURTEVANT. U. S. 1,673,342, June 12, 1928. An eccentric mechanism comprising a casing having separable upper and lower parts with openings in the ends thereof, journal boxes in the openings, a shaft, bearings for the shaft in the boxes and each comprising an outer raceway in the box, an inner raceway on the shaft, and rotative elements between raceways, an eccentric on the shaft between the boxes, a housing for the eccentric having apertures in the ends thereof receiving the shaft, the housing being formed to receive a follower; a bearing in the housing comprising a raceway on the eccentric, a raceway on the housing, and rotative elements between raceways, the upper part of the casing being removable from the lower part of the casing to permit the shaft, its boxes, the eccentric, and its housing and bearing to be removed as a unit from the casing.

Air separator. THOMAS J. STURTEVANT. U. S. 1,673,343, June 12, 1928. An air separator for grading materials comprising an outer casing, an inner casing of upper and lower shells having a space between them, a series of spaced vanes in the space, the inner casing having a separating chamber therein, the casings having a settling chamber between them, means for causing air to circulate through the chambers and through the spaces between the vanes, and means for pneumatically removing from the spaces between the vanes any materials accumulating therein.

Thermostats and valves. H. J. YATES, M. HOWLETT & CO., LTD., AND J. DOLPHIN. Brit. 286,831, May 2, 1928. An automatic valve such as a thermostat has a casing formed with upstanding walls to form an inlet chamber communicating with a tangentially arranged inlet and an annular outlet chamber communicating with a similarly arranged outlet, the controlling valve being arranged to seat on the top of the inner wall. The inner chamber is provided with a frustro conical strainer preferably of sheet

metal with a number of narrow axial slits arranged with its larger diameter uppermost in contact with the inner wall and its lower end engaging a boss. The valve member which is loaded by a spring has a depending guide engaging the boss and provided with an adjustable abutment for engaging the operative member of the thermostat. The abutment is screwed into the guide and has a flattened part engaged by a slot on an adjusting spindle operated by a cap provided with indicating markings. A throttling screw may be arranged in the inlet.

Conveyers. A. EICKHOFF. Brit. 286,979, May 2, 1928. The supply of material to a jigging conveyer is facilitated by a ramp which may be stationary, connected to the conveyer, or driven by a motor. When the conveyer and ramp are connected, the direction of movement of the conveyer is oblique to its length. When the ramp has its own driving means, its movement is directed obliquely toward the conveyer. The wall of the trough is higher than the wall adjacent to the ramp.

Rotary fluid meters. A. E. GRANGER. Brit. 287,143, May 9, 1928. The piston of a gyratory piston rotary meter is of U-shape in axial section and the web is recessed to form a balancing space which is open to the pressure in the interior of the piston through holes in the web. The web is formed with a central boss to actuate the arm of the counter mechanism and the opening in the piston wall which engages the abutment in the cylindrical chamber is enlarged to form ports opening into the piston interior. The cylindrical working chamber is formed by a disk which carries an inner cylinder and on which an outer cylindrical ring is positioned by a nipple engaging a recess, the whole being covered by the disk carrying the counter mechanism. Liquid enters at the meter inlet and passing through a strainer and port in the disk into the working chamber is discharged through a port in the cylinder to the meter outlet. To prevent corrosion the parts exposed to the liquid may be of ebonite or nickel.

Pyrometers. ELECTROFLO METERS CO., LTD. Brit. 288,105, May 23, 1928. A casing for housing the connection between the elements of a thermocouple and the conductors leading to the measuring instrument is made in two separable parts, one of which is provided with openings to receive the thermocouple elements and the conductors. The elements pass through a sleeve threaded into the lower part of the casing and through an insulating block also seated in the lower part. The upper parts of the elements are threaded to form binding posts on which are secured the conductors which pass out through an armour secured in the lower part. The part forming the cover of the casing is secured to the lower part by screws.

Rotary engines and pumps. C. T. BARCLAY. Brit. 288,420, May 31, 1928. To reduce the back-pressure in reversible rotary engines or pumps of the outwardly sliding vane or roller type having interchangeable inlet and outlet ports at the ends of the working chamber, auxiliary exhaust ports are provided in the casing at the points where the intervane space begins to decrease, which are controlled by valves actuated by the working-fluid and interconnected so that one valve is closed and the other opened automatically on reversal of the engine; these valves are situated in a valve chest provided with branch pipes leading to the auxiliary ports and with an exhaust pipe. Pressure fluid passing through the auxiliary port into the branch pipe closes the valve, the spindle of which moves the other valve to the open position. The engine is reversed by admitting pressure fluid to the former exhaust port whereupon the open valve is closed by the pressure fluid passing through the auxiliary port to the branch pipe and the other valve is opened.

Kilns, Furnaces, Fuels, and Combustion

Principles of combustion. C. G. SEGELER. *Ceram. Age*, **11** [5], 176–77 (1928).—Fuels are all composed essentially of carbon, hydrogen, and sulphur. Sulphur occurs

only in the natural fuels and only in small amounts in the higher grades. S. gives the B.t.u. values of coals, oils, and gases. Luminous flames have a low efficiency and flame temperature and require a great deal of excess air. Nonluminous flames contain primary air and are hotter and shorter. S. lists the important combustion reactions, shows how Avogadro's Law can be used for calculating the air required for combustion, explains carbon dioxide and nitrogen calculations, and discusses primary and secondary reactions in burners and the principles of surface combustion. The relation between heat transfer and flame temperatures and the difficulties encountered in measuring the latter are pointed out. Specific application to ceramic work is made in a discussion of kiln setting and design, the utilization of waste heat, and atmosphere control.

A.E.R.W.

Heating with gas in the ceramic industry. G. MEKER. *La Céramique*, **30** [473], 160–65 (1927).—In discussing the use of gas in the ceramic industries, M. quotes examples to show that there are cases in which the use of gas is economical, *e.g.*, in the manufacture of steatite spark plugs. In test furnaces, the use of gas enables one to secure high temperatures rapidly and at a controlled rate. Control of atmosphere is also easy. Gas should not be compared with other fuels by comparing the cost of calories but rather by comparing the cost of the finished product when made with the different fuels. A table for making an accurate comparison is given. Recuperators are discussed at length. A.E.R.W.

Heat recovery in furnaces. W. TRINKS. *Glass*, **4** [8], 334–35 (1927).—For abstract see *Ceram. Abs.*, **6**, [11], 537 (1927). A.J.M.

Portable oil firing unit. ANON. *Glass*, **4** [11], 493 (1927).—The unit comprises a steel frame on which is mounted the "Rotamisor" burner and combustion chamber, an oil tank from which the oil flows by gravity to the burner, and an electrically-driven fan for supplying the air for combustion, the whole being mounted on wheels. The burner can be raised or lowered vertically through a distance of 18 inches, while in addition, the burner being mounted on trunnions, the vertical angle of the flame can also be varied through 30°. A.J.M.

The chemical study of processes involving the carbonization of coal by internal heating. M. W. TRAVERS. *Glass*, **5** [1], 23 (1928).—A detailed discussion is given of the chemical and thermal reactions which occur during the distillation of bituminous coal.

A.J.M.

A new short flame burner for the firing of pulverized fuel. ANON. *Glass*, **5** [1], 31 (1928).—The objection to this type of firing has been the great length of flame required for complete combustion. For example, with large water tube boilers, having a row of burners of the usual type, pointing downward, the length of flame is about 30 ft. and a combustion chamber of about 50 ft. is required. The new burner, on the "turbulent" principle, is claimed to give complete combustion in a flame only about 10 ft. long. As a result the combustion chamber volume may be reduced about 50%. The primary air (about 15% of the total) enters through a center opening with the coal. The remaining 85% as secondary air is given a violent cyclonic motion by means of spiral ribs. Separation of the air and coal particles at the burner tip is impossible. The only adjustment necessary is a single slide damper on the secondary air supply pipe. A.J.M.

Liquid fuel from coal. DAVID BROWNLIE. *Can. Chem. Met.*, **12** [5], 123 (1928).—This question is of vital importance in Great Britain at the present time, and the author covers the most important aspects of the situation. Reference is made to 30 of the 75 low temperature carbonization processes now operating in various countries, and the details of equipment and methods used in these different plants make very valuable and interesting reading. One of the best known British processes is that of the Power Gas

Corp., which consists of a Mond gas generator with an extremely deep fuel bed, so that the descending charge is given progressive but slow carbonization, with the consequent recovery of a definite and valuable low temperature tar entirely different from the shallow Mond generator in which the tar is valueless, being badly cracked. In the fusion retort process, used at several British plants, a rotary cylinder is externally heated under very carefully controlled conditions, to a temperature of 800°F, and inside is a series of heavy loose breakers, which roll around along the charge and prevent the deposition of carbonized particles on the retort walls. B., taking a rough average, estimates that 1T. of bituminous coal, 25–35% volatile matter, will give about 18 gallons of crude oil per ton, and 2–2½ gallons of light oil scrubbed from the gas.

E.J.V.

Furnace design for high capacity. E. G. BAILEY. *Blast Fur. Steel Plant*, **16** [3], 390–95; [4], 511–13 (1928).—Boiler furnace operation is here set forth as it is found in plants of modern design. Construction of furnace walls, bottoms, etc., has important bearing on combustion and over-all economy. The boiler furnaces of 25 years ago were relatively small, and rate of combustion up to 50,000–80,000 B.t.u. per cu. ft. of furnace volume per hour was not uncommon. The boilers were set low and absorbed so much heat from the furnace walls that maintenance of brickwork was not much of a problem except at the clinker zone when burning coal. The principal difficulty was to secure complete and smokeless combustion. Improvement in efficiency was made by raising the boilers, and year after year furnace volumes were made larger with each new installation. Better combustion and less smoke resulted from the higher furnace temperatures and lower rates of combustion per cubic foot of furnace volume, but more trouble from furnace brickwork was soon evident. This was to be expected as the ratio of areas of furnace wall to the boiler tubes exposed to furnace radiation had increased greatly and the brickwork was heated beyond the fusion point of the ash of much of the coal burned. In an effort to avoid furnace-wall trouble the furnaces were made still larger, the walls were moved farther away from the active flame, and the flame was "softened" as much as possible, especially in pulverized coal fired boilers. The refractory walls were still a serious source of expense for outage and repairs, and there was the added difficulty of getting the ash out of the furnace due to slagging of the boiler tubes or choking of the ash grates. These conditions resulted from heating coal ash above its fusing point, and applied equally to stoker and pulverized-coal plants. The accumulation of slag on the boiler tubes choked the gas passages and directly limited the boiler capacity. The remedy has been found in more complete combustion of the particles of coke before reaching the tubes and in the proper spacing of the front rows of boiler tubes. The use of soot-blower elements properly located and protected, supplemented by hand lancing in some cases, permits the satisfactory operation of boilers in this respect. The removal of ash was made easier by the addition of air through hollow walls and ventilated blocks, or the addition of some water boxes and cooling tubes along the slag line and in the lower part of the furnace. These meager remedies were successful in some cases and failed completely in others, the difference being largely due to the influence of the fusing point of the ash in the coal being burned or some unnoticed difference in the relative location of the boiler tubes for absorbing radiant heat from the furnace. The better designed furnaces were often forced to higher ratings until trouble was again experienced. The present tendency of furnace design is to rectify this situation by greater turbulence in combustion and the building of furnaces that will withstand high rates of combustion continuously with minimum outage and maintenance expense. So many engineers in both the manufacturing and operating groups are working diligently on this problem that the economic answer will soon be worked out. It is the purpose of this paper to report some

progress in furnace designs for high capacities. From this brief history of the experiences of the past it is observed that the principal factors controlling furnace designs are (1) complete combustion with a minimum of excess air, (2) controllable rate of combustion over a reasonable range, (3) long endurance of furnace walls, (4) prevention of slag on boiler tubes, (5) removal of ash. F.P.H.

Utilizing waste heat by means of boilers. ANON. *Blast Fur. Steel Plant*, **16** [4], 508–10 (1928).—An appraisal of the economies to be derived by extracting heat from the spent gases from engines, producers, and furnaces. A new type of boiler is presented. F.P.H.

Improved decorating kiln. ANON. *Ceram. Ind.*, **10** [6], 630–31 (1928).—At the plant of the Acme China Co., Murphysboro, Ill., is a decorating kiln which is coal fired and requires but 4 shovelfuls of coal per hour to keep it up to cone 013. The kiln is built of brick and is in the form of a rectangle with the fourth side missing. The entire interior of the kiln is a muffle with an 8-inch space between it and the kiln wall. The air for cooling the ware enters through two 6- x 6-inch vents in the cold end of the kiln and passes around in the top of the cooling chamber. F.P.H.

High-frequency induction furnace. E. BALL. *Chem. and Ind.*, **47,** 502 (1928).—Analysis of the operation of these furnaces shows that the heat generated in a cylindrical charge and the energy lost in heating the coil become proportional to the square root of the frequency of the energy supply after the frequency has attained a certain critical value. It follows that above this value, the efficiency of the furnace is independent of the frequency. H.H.S.

Coke for crucible steel melting. R. V. WHEELER. *Fuel*, **7,** 148–51 (1928).—The preference shown by crucible steel workers for beehive over by-product coke is due to the readiness with which the former can be broken into pieces of suitable size without undue formation of breeze, and the fact that it burns uniformly at an economical rate and that the clinker formed does not stick to the furnace lining. These advantages arise from the absence of cross-fractures and the uniform cell-structure in beehive coke, combined with possession of the requisite "combustibility value." A special coke produced in a by-product oven from a blend of coking slack and anthracite duff behaved satisfactorily in trial melts in regard to manner of burning, but was difficult to break into suitable pieces and gave rather a high proportion of breeze. (*B. C. A.*)

Reactivity of coke. J. H. JONES, J. G. KING, AND F. S. SINNATT. *Iron and Steel Inst.*, 20 pp., May (1928); Advance copy,—A comparison of the reactivities of a number of metallurgical cokes has shown that the cokes from Yorkshire coals are distinct from those of South Wales or Durham coals, and possess a higher reactivity. The reactivity curves for the South Wales and Durham cokes are similar, the latter, however, giving slightly higher average values than the former. The differences are probably due to differences in the character of the coals used, and there is some indication that the ash is an important factor. Attempts to correlate reactivity values of metallurgical cokes with the results of "shatter" tests have met with no success. (*B. C. A.*)

Reactivity of coke and a new method of determining it. R. A. DENGG. *Polytechn. Weekblad*, **20,** 246 (1926); *Fuel*, **7,** 152–54 (1928).—Three cokes were prepared in the laboratory by carbonizing an anthracite, a coking coal, and a gas coal, respectively, at 950°. Their relative "reactivities" were determined by passing air at a constant rate (5 liters/hr.) over 0.2 g. of the coke, of uniform size, placed in a boat in the tube of a furnace maintained at a constant temperature, and measuring the amount of carbon dioxide produced. This was done by observing the variation in electrical conductivity of a solution of barium hydroxide through which the issuing gas was passed. The coke

from the anthracite had the least reactivity, and that from the gas coal the greatest. The distinction between "reactivity" and "combustibility" is emphasized. (*B. C. A.*)

PATENTS

Furnace. ERVIN G. BAILEY. U. S. 1,670,295, May 22, 1928. A furnace the wall of which is provided with a plurality of air-inlet ducts to the combustion chamber, combined with automatic valves in the ducts adapted to be opened by the pressure of the incoming air, and means for providing a predetermined yielding resistance to the opening movement of each valve proportioned relative to that of the other valve to effect a corresponding relative distribution of the air in the several ducts which is thus maintained substantially the same at all rates of air inflow.

Furnace-wall construction. JACK E. BIGELOW. U. S. 1,670,490, May 22, 1928. In a furnace-wall construction, the combination of a metal framework, an upright brick wall composed of alternate horizontal rows of bricks supported directly by the metal framework, and other alternate horizontal rows of filler bricks supported in part directly by the framework.

Variable feed for stokers. CYRUS J. PARKER. U. S. 1,670,518, May 22, 1928. A variable feed for stokers having, in combination, a stationary internal gear; an eccentrically mounted pinion meshing with the gear; a crank actuated by the pinion; a pawl mounted on the crank; a ratchet concentric with the internal gear; a shaft driven by the ratchet; and cam means for moving the pawl into momentary engagement with the ratchet.

Furnace for drying fuel. ERNEST WINDSOR BOWEN. U. S. 1,670,606, May 22, 1928. An improved furnace for drying fuel comprising an elongated chamber, a plurality of individually adjustable gas burners spaced along the length of the chamber, a plurality of individually adjustable burnt gas outlets spaced along the length of the chamber, means for conveying continuously the material to be dried through the length of the chamber between the burners and outlets, and a baffle composed of spaced sheets of refractory material located between the conveying means and the gas outlets.

Furnace-firing apparatus. JAMES D. LALOR. U. S. 1,670,626, May 22, 1928. In a furnace-firing apparatus, the combination of a carbureting burner, means supplying liquid fuel to the burner, a blower for concurrently supplying combustion-supporting air to the burner for commingling with the fuel, means adjustable to regulate admission of air to the blower, means automatically operated by the fuel delivery pressure to govern the passage of air from the blower to the burner, and separate gravity-influenced automatic means supplying an auxiliary quantity of air proportionate with the velocity of the fuel mixture to the discharge from the burner while enroute to the furnace.

Producing briquets and product thereof. WILLIAM T. MILLER. U. S. 1,670,865, May 22, 1928. A process which comprises applying an adhesive composition to a finely divided carbonaceous material, the adhesive composition containing a glutinous substance dissolved in water which has been partially thrown out of solution by a precipitant and also containing a soluble silicate.

Water-gas machine valve-controlling apparatus. THOMAS W. STONE AND WALTER BARR. U. S. 1,670,911, May 22, 1928. In a sequence control device for gas-making apparatus valves, in combination: a power transmission device adapted to be connected with a series of power lines respectively leading to and operating a plurality of such valves; a unitary control member adapted to traverse the transmission device and successively and directly admit and intercept the flow of power through the transmission device directly to the power lines; a manual drive and a power drive for the unitary control member for effecting alternatively manual or power operation of the unitary control device substantially as specified.

Regenerative open-hearth furnace. STEWART J. CORT. U. S. 1,671,100, May 29, 1928. In a regenerative furnace, in combination, inwardly extending walls defining a throat and water-cooled members disposed entirely to the inner sides coöperating with the innermost portions of the walls.

Process for coke-oven heating. HEINRICH KOPPERS. U. S. 1,671,194, May 29, 1928. In operating a regenerative gas-fired coking furnace having a combustion chamber in which the direction of the draft is periodically reversed, and having air supplies, gas supplies, and regenerators communicably connected with the combustion chamber, and in which a coal charge is being coked by combustion of gas and air in the combustion chamber, the improvement for increasing the heat economy of the coking furnace comprising: effecting a cessation of combustion therein by shutting off the supply of gas thereto; lowering the temperature of the hottest portions of the furnace and distributing heat therefrom to relatively cooler portions of the furnace and to the coal charge during the cessation, by flowing air alone through the combustion chamber during the cessation and for a substantial interval after substantial combustion therein has ceased, so as to permit the air to act as a mere heat carrier and distributor and effecting, through the air flow, a transfer of heat, by convection and absorption, from the hottest to the relatively cooler portions of the combustion chamber and regenerators; thereby minimizing the temperature differences throughout the furnace, thereafter introducing the gas to the combustion chamber, and resuming the combustion in the combustion chamber while the charge is in the furnace.

Retort oven. HEINRICH KOPPERS. U. S. 1,671,195, May 29, 1928. An oven plant having in combination: vertical retort chambers; parallel vertical heating-flues; regenerators so arranged that the combustion gases being preheated flow through them from bottom to top and that the off-going waste gases flow through them from top to bottom; an upper horizontal channel directly connecting the vertical heating-flues with the top of one of the regenerator groups; a lower horizontal channel and a guide channel so arranged that vertical heating-flues are connected by the lower horizontal channel and through the interposed guide channel with the top of the other regenerator group.

Oil burner for lime kilns. FEDERICO FIRPO AND JOSÉ ANTONIO BECARRA. U. S. 1,671,234, May 29, 1928. An oil burner, comprising an elongated body portion; a longitudinal partition in the body portion dividing the interior thereof into upper and lower longitudinal chambers; an enlarged head at the rear end of the body portion; a vertical S-shaped partition in the head and dividing its interior into two compartments, one opening at its top into one chamber, and the other opening at its bottom into the other chamber; liquid fuel supply means opening into one compartment; steam supply means opening into the other compartment; and fuel and steam discharge nozzles attached to the front ends of the respective chambers.

Kilns for firing clay products, glazed ware, and pottery. HENRY WEBSTER. U. S. 1,671,559, May 29, 1928. In a plurality of kilns in which the annular flue of each kiln is connected by a short flue with the annular flue of the next adjacent kiln, the combination with a central longitudinal flue common to all of the kilns of the series and in operative communication with the well of each kiln and with each of the short flues, of a 2nd longitudinal flue running alongside and common to all the kilns of the series, and transverse flues passing between adjacent kilns and adapted to establish communication between the 2nd longitudinal flue and the central longitudinal and short flues, operative communication between the several flues being controlled by dampers.

Hydrocarbon burner. W. CLAUDE HOLLAND. U. S. 1,672,064, June 5, 1928. A hydrocarbon burner including a burner body substantially cylindrical in form and provided with an air inlet, an elongated cylindrical air nozzle carried by the body, a bracket formed with a nipple which is fitted into the other end of the burner body, a

tubular sleeve anchored to the nipple and disposed within the body, a tubular shaft extending axially through the nipple and through the sleeve, antifriction bearings in the nipple and in the free end of the sleeve in which the shaft runs, an oil line extending axially through the shaft, an atomizing nozzle within the air nozzle and fixed to the adjacent end of the shaft and having a bearing on the oil line, a head fixed to the oil line within, spaced from the atomizing nozzle, and formed with an internal chamber having discharge outlets leading therefrom.

Fire pot for fuel-oil burners. WILLIAM J. PRESS. U. S. 1,672,084, June 5, 1928. A fire pot comprising a vertical bowl having a central bore in the base thereof and a flanged oil feed opening entering tangentially through the side wall thereof; a hollow standard exteriorly flanged at both ends; and a centrally perforated baffle plate, the standard resting in the central bore on the shoulder afforded by one flange and supporting the centrally perforated baffle with the other.

Fuel cut-off means for power-operated liquid fuel burning apparatus. SINIUS M. HANSEN. U. S. 1,672,213, June 5, 1928. A liquid fuel burning apparatus comprising a motor, a blower, a pump, a pilot, a burner tip portion, a main fuel supply means, cut-off means for the fuel supply means, a drip catcher located below the tip portion and pilot, a reservoir arranged to collect drip from the catcher, a float in the reservoir, a stem upwardly extending from the float, a member arranged to co-act with the stem to break a toggle, a toggle arranged to be broken through the agency of the stem and member, a member arranged to be operated upon the breaking of the toggle to release the cut-off means to cut off the fuel supply, and means to drain the reservoir.

Coke-extracting mechanism for vertical retorts for the distillation of carbonaceous materials. FREDERICK J. AND ERNEST WEST. U. S. 1,672,442, June 5, 1928. In coke extractors for vertical retorts, the combination with each retort of a pivotally mounted coke chamber having a ram adapted for reciprocation therein and capable of withdrawal therefrom, means for turning the chamber about its pivotal support or supports for coke-discharging purposes, means for closing the lower end of the retort during such discharge, and means for effecting such closure when the chamber is returned to its receiving position and before the ram is raised therein to support the retort contents.

Furnace. DAVID S. JACOBUS AND WILLIAM A. JONES. U. S. 1,672,532, June 5, 1928. An oil-burning furnace comprising an inclined furnace wall composed of tile and an oil burner set in the wall, at substantially right angles thereto.

Chain-grate stoker. ALFRED GEORGE FOX. U. S. 1,672,563, June 5, 1928. In a chain-grate stoker, a plurality of transverse draft boxes between the upper and lower runs of the grate, each box being open at the top to receive solid particles sifting through the upper run of the grate and having its sides converging downward to collect such particles in the lower narrow part of the box, and each box having a valve in its bottom arranged to permit discharge of such particles onto the lower run of the grate while maintaining a seal against the escape of air from the box, and a conduit supplying draft to the boxes.

Electric furnace. HAROLD L. WATSON. U. S. 1,672,667, June 5, 1928. A high temperature electric furnace comprising heat refractory walls forming a heating chamber, and a heating resistor in the chamber comprising a plurality of bars of heat refractory material arranged vertically in spaced relation around the side wall of the chamber, and cross pieces joining the bars at their upper and lower ends to form a continuous heating resistor extending along the side wall of the chamber and resting on the lower cross pieces.

Fuel-distilling apparatus. FRANK E. HOBSON AND JAMES F. SHELTON. U. S. 1,672,860, June 5, 1928. In a retort comprising a vertical retort shell, a centrally located, vertical gas collector therein and spaced therefrom, means adapted to heat the

retort shell, a vertical cylindrical hanging louvered curtain between the gas collector and shell and proximate to the shell, spaced from the gas collector, and means adapted to shift the curtain vertically, whereby material in the retort between the gas collector and the curtain may be prevented from contacting with the shell while being carbonized by heat therefrom, and may be caused to move downward in the retort.

Firing arrangement for muffle furnaces. WILLIAM J. HARRIS, JR. U. S. 1,672,862, June 5, 1928. In combination a furnace chamber, a muffle within the chamber, means for introducing heating gases below the muffle in a direction transverse to the length thereof, and means for diverting a portion of the heating gases back to the side wall nearest the means.

Recuperator. JOSEPH LUNDBORG. U. S. 1,672,864, June 5, 1928. A recuperator assembly comprising the combination of a plurality of hollow refractory tile having spaced open channels extending transversely to the bores about the entire periphery thereof, the tile being arranged end to end in rows and side by side in parallel courses in an outer casing to form with their interior bores a series of sinuous broken paths traversing the recuperator from end to end and to form with their exterior channels enclosed ducts extending in a zigzag direction through the recuperator in planes lying at right angles to the planes of the parallel courses and tile bores.

Unit heater control. HAROLD W. SWEATT. U. S. 1,673,057, June 12, 1928. A device of the class described comprising a heater, a valve for controlling heat supply thereto, a fan motor arranged to circulate air warmed by the heater, a circuit for the fan motor including a switch, a control motor, and a shaft rotatable thereby, a circuit for the control motor including a switch and a coil for operating the switch, means associated with the switch and operable by the shaft for holding the same in closed positions, and for allowing the switch to open, a thermostatically responsive room device, a device responsive to fluctuations in heat supply at the heater, each device having contacts engageable by a movable member, switches adapted to close circuits to the coil for control through the contacts of the room and radiator device, switch controlling elements rotatable with the shaft, one for each last-mentioned switch, and for the fan switch, the elements arranged to close the switches to allow energization of the coil respectively by either device, by the radiator device only, and by the room device only.

Oil burning mechanism. ORVILLE ALDEN FOGARTY. U. S. 1,673,110, June 12, 1928. An oil burning mechanism, comprising a vacuum tank, directly connected to the oil supply, a mixing chamber having air and oil inlets and an air and mixture outlet, a rotary pump connected to the vacuum tank indirectly through the mixing chamber, a discharge pipe from the pump terminating in an upturned nozzle, a forced draft air tube containing the discharge at the bottom thereof and widened at the mouth to form a horizontal inward taper and a vertical outward taper, a blower delivering air to the tube, a motor grouped with the pump and blower and associated parts, and a spark plug within the tube having extended electrodes and extensions therebeyond over the nozzle.

Preparing solid fuels for burning in pulverized form. LEE B. GREEN. U. S. 1,673,114, June 12, 1928. The method of preparing solid fuel for burning as pulverized fuel which consists in initially pulverizing the fuel, then compressing the pulverized fuel into briquets, and then removing the pulverized fuel from the surfaces of the briquets and immediately delivering to a burner.

Crucible. EARL L. HAUMAN. U. S. 1,673,115, June 12, 1928. A crucible comprising a pot provided in its upper edge with a substantially semicircular outlet, and a lip which is trough shaped in cross-section and arranged in line with the outlet and has its bottom arranged slightly below the lower part of the outlets.

Recuperator. CHARLES P. MILLS. U. S. 1,673,122, June 12, 1928. In a recuperator, a chamber through which the furnace gases are horizontally passed, a plurality of horizontal manifolds mounted above the chamber and transversely disposed to the path of the waste gases, a plurality of parallel U-shaped air tubes depending within the chamber and connecting together adjacent manifolds in pairs, and means for admitting the air to one of the manifolds and discharging the air from the other manifold of a pair, the air being admitted or discharged at both ends of the manifolds.

Rotary fuel-burner assembly. JOHN H. STEWART. U. S. 1,673,302, June 12, 1928. In combination with an oil burner assembly, a casing enclosing the assembly, a mounting member provided with slidable supporting means for the assembly, which comprise a saddle on which the oil burner assembly is vertically pivoted, the saddle having slidable engaging members slidable on the mounting member.

Water-cooled furnace wall. BENJAMIN N. BROIDO. U. S. 1,673,390, June 12, 1928. A protecting wall for heated structures comprising spaced tubes exposed on one side and adapted to contain a cooling fluid and bridging pieces of heat-conductive material separate from the tubes and closing the spaces between them, to form with the tubes a continuous heat absorbing surface, each of the bridging pieces comprising a central web portion bridging the space between adjacent tubes, a pair of curved side portions the inner surfaces of which form sockets in which only the rear portions of the tube are seated, and detachable means for forcing the sockets into close contact with the tubes.

Kiln hood and support. ALVIN H. COLBERT, CHARLES R. MCCONNER, AND RALPH L. BAKER. U. S. 1,673,396, June 12, 1928. A traveling structure adapted to be moved into place over a brick kiln comprising a gas collecting hood, rolling supports therefor, means carried by the parts for supporting the walls of the kiln, and other means carried by the parts for closing the space between the top of the kiln and the bottom of the hood.

Electric furnace. ERNST WIRZ. U. S. 1,673,543, June 12, 1928. An electric resistor heater comprising a continuous resistor heating element wound into a plurality of loops, a pair of spaced supporting members engaging the opposite bights of the loops which are loosely mounted on the members and held stretched thereby, and guide rods engaging the members to permit sliding movement of one member with respect to the other.

Furnace control system. JAMES C. WOODSON. U. S. 1,673,544, June 12, 1928. The combination with a furnace, heating means therein, and motor-operated means for moving material through the furnace, of means for controlling the energization of the heating means in accordance with the load on the motor of the material-moving means.

Furnaces. KOKSOFENBAU AND GASVERWERTUNG AKT.-GES. Brit. 288,538, June 7, 1928. Regenerators for coke ovens having horizontal chambers are formed of pipes or tubular blocks arranged in parallel so as to fill the regenerator chambers. The hot waste gases or the medium to be heated pass both around and through the pipes. Pipes of large cross-section and pipes of smaller cross-section may be arranged in alternate rows. The regenerator chamber is divided by a horizontal baffle. Long pipes may be used or short tubular sections arranged in line.

Vertical coke ovens. KOPPERS CO. Brit. 288,558, June 7, 1928. In a vertical chamber coke oven, the oven structure is supported by air-cooled frames which are carried by horizontal foundation beams and are so arranged that they may expand in a horizontal direction relatively to both the oven structure and the foundation beams. Frames having openings corresponding to the lower ends of the coking chambers, extend between the concrete foundation beams, adjacent frames extending under and supporting half a heating wall and having between them a gas-tight expansion joint composed of pitch retained in position by asbestos rope. A pitch expansion joint is also provided between the frames and the beam. Each frame is formed at its upper end with a hollow

flange having perforated internal vertical webs which divide the flange into compartments, each communicating with the atmosphere, some through openings and others through vertical passages. The cooling air passing upwardly into the hollow flange passes thence into the spaces between the additional flanges embedded in the beams, and finally escapes to the atmosphere through passages in the side walls of the battery. Each frame is also formed with upper and lower inwardly extending flanges between which is supported a heat insulating lining. Pipes fitted with movable caps extend through the flanges and register with inspection passages extending upwardly to the waste gas flues. A casing housing the coke extractor mechanism, is secured to the underside of each frame and supports in turn a coke-receiving chamber fitted with a water-sealed discharge door. The casing is inclined to one side, and fitted with a shaft carrying a series of toothed wheels which coact with hanging flaps to discharge the coke into the receiver. Between the frame and the extractor are water pipes for quenching the coke, the quenching water being collected in a trough which directs it on to the inclined walls of the receiver down which it flows to the water water-seal. The trough is tiltable, by means of a handle, about a longitudinal axis to dump any breeze that may have collected therein, and a water jet is provided for flushing out the trough when necessary.

Coke ovens. KOPPERS CO. Brit. 288,566, June 7, 1928. The head of a pusher ram for discharging horizontal coke ovens is constructed with a projection which engages that portion of the charge offering the greatest resistance, *i.e.*, the lower part, before the remainder of the head contacts with the coke. The ram head is carried by a motor-operated bar mounted on a wheeled carriage and is formed, at its lower part, with a projecting portion having a vertical face which, at the commencement of the discharging operation, exerts pressure on the bottom layer of coke in the oven before the main surface of the head engages the upper parts of the charge. A modification is described in which the head is formed, in addition to the projection, with further projections arranged in steps. In each case, there is pivoted to the lower part of the projection a counterweighted plate which is so arranged that it can pivot forwardly only and so ride over any loose coke during withdrawal of the pusher.

Coke ovens. KOPPERS CO. Brit. 288,622, June 7, 1928. In apparatus for levelling charges in horizontal coke ovens comprising a reciprocated leveller bar of skeleton structure, there is a cushioned lost-motion connection between the bar and its driving device and means are provided, within the structure, to remove any coal that may have lodged within it. The leveller bar is carried on the coke pushing machine, being supported by rollers and driven by a cable which is wound on a drum geared to an electric motor and, passing over pulleys on the machine framing, has its ends secured by a clamp, to a cross-head. This latter comprises a body portion having, at each end, an I-shaped extension which slidably engages upper and lower channel members secured between the side plates of the leveller bar. To the outer ends of the extensions are secured abutments adapted, at the ends of the travel of the cross-head, to engage buffer-springs which bear against blocks attached to the side members. A rod secured to the forward end of the cross-head is slidably supported in plates, which with the spacing tubes, connect the side members and carries plates which serve, during the movement of the cross-head relative to the bar itself, to remove any coal that may have lodged within the structure.

Burners, etc. H. BENTLEY. Brit. 288,721, June 7, 1928. In a heavy fuel burner which is automatically stopped or started in accordance with the conditions in the unit being heated the pressure developed by the electrically driven fan or blower supplying the combustion air is utilized at starting to deliver a predetermined amount of petrol or other liquid fuel to a pilot or starting burner for ignition purposes. A liquid fuel

burner apparatus is described which is suitable for firing a steam generator for motor vehicles. It comprises a high speed electric motor having a hollow armature shaft carrying a centrifugal fan and an atomizer. Liquid fuel is supplied to the atomizer through a pipe arranged in the shaft and fitted with a valve which is opened electrically against the resistance of a spring by a solenoid. The atomizer preferably consists of a cone formed with apertures through which part of the oil is fed to a surrounding cone. The cones are formed with air inlet apertures and may have their outer edges serrated. The fan delivers air, which may be preheated, to the atomizer through conduits. At starting the air pressure exerted by the fan is communicated to a chamber by a pipe connecting an inlet to a vent on the fan casing. The chamber becomes filled with petrol or other inflammable liquid when the fan is at rest from a float chamber through a passage fitted with a nonreturn valve. The air pressure in the chamber closes the valve and forces the petrol through a pipe to a burner tray where ignition is effected by a spark plug, thereby creating a flame directed across the path of the fuel from the atomizer. The burner is started by closing the switch of an accumulator or other source of electricity to supply current through a circuit breaker to the motor, the solenoid, and an induction coil connected to the spark plug. After an interval during which the petrol forced to the tray becomes ignited the air pressure of the fan is sufficient to operate a diaphragm with a casing against spring pressure and break the primary circuit of the coil. If the pressure in the steam generator being heated exceeds a predetermined amount a pressure-sensitive device operates to communicate pressure from a pipe through a pipe to the diaphragm chamber of the circuit breaker and thereby stops the motor and closes the valve. When the pressure subsequently has fallen to below the predetermined amount the device operates to relieve the pressure in the diaphragm chamber and to remake the circuits to the motor solenoid and induction coil. The device many alternatively be arranged to reduce the speed of the motor previous to or instead of stopping it. A burner apparatus is described in which a pulverized fuel burner comprising an electrically driven rotating conical cup is ignited by a pilot burner constructed similarly to that previously described. The feed through the stationary or rotating pulverized fuel supply pipe may be subjected to the control of a sensitive element while the burner once lit burns continuously. A liquid fuel burner may be substituted for the pulverulent fuel burner.

Manufacture of water-gas. N. J. Bowater. Brit. 288,797, June 7, 1928. In a continuous process of making water-gas, pulverized fuel such as coal or coke is fed through inlets in a chamber and is showered in counter current to steam supplied by a pipe, the heat for the reaction being maintained by a heated surface such as a hollow cylinder heated by combustion of solid or liquid fuel or electrically, the water-gas escaping through an outlet. The ash is discharged through an outlet. The cross-section of the upper part of the chamber is increased to decrease the upward velocity of the steam and prevent particles of fuel being swept out with the water-gas. The combustion products from the apparatus may be used to raise steam or preheat the air or fuel.

Furnaces and kilns. K. Ruetz. Brit. 286,626, May 2, 1928. In fuel-charging apparatus for brick kilns, the hopper disposed above the charging hole is shut off from the kiln and encloses mechanism for cutting off the fuel in layers from the top downwardly and delivering the cut-off layers into the charging pipe. The latter is vertically movable within the hopper, being supported by the engagement in teeth of the end of a spring bolt which is carried by the hopper cover, this cover being mounted to rotate by means of rollers running on a ring secured to the upper end of the hopper. A vertical square shaft is journaled in lugs on the pipe and is guided in the cover by a cylindrical sleeve above which a handle is loosely mounted on the shaft. Below the cover the shaft

passes through a boss to which is pivoted an arm adapted to engage in a notch in a member secured to a ring which is mounted on a flange of the ring. Closely encircling the ring is a steel friction drive band, the ends of which are joined by a spring and adapted to be oscillated from a driven crank through ball-jointed levers. On the lower end of the shaft is secured an arm the outer end of which is connected by a link to the short arm of a cranked lever pivoted on an arm and having its long arm shaped to form at its end a shovel or pusher. The arm is carried by a hub which is loosely mounted on the shaft to engage over the lug and carries symmetrical projections adapted to bear in turn, as the shaft is oscillated, against the tube. The latter is formed with an opening normally closed by an internal hanging flap and has, secured on its outer surface, a knife which is shaped to correspond to the path traversed by the pusher and has an upturned outer end. In operation, when the hopper has been filled with fuel and the cover and tube replaced with the knife resting on top of the fuel, the handle is turned to connect the parts and thus engage the driving gear. On the forward stroke of the crank the shaft, with its associated mechanism, rotates, the projection coming into contact with the pipe and the pusher moving inwardly over the knife. The mechanism is now locked and further forward movement of the crank produces rotation of the whole system including the pipe, the knife being thus advanced into the fuel. Reversal of crank withdraws the pusher and moves it, during the rotation of the shaft, to its outermost position, backward movement of pipe being prevented by a spring brake-bolt which engages the cover and causes the band to loosen on the ring. On the next forward stroke of the crank the layer of fuel cut off by the knife is pushed by the shovel through the opening into the feed pipe, this action being constantly repeated. When the knife has made a complete revolution of the hopper, the bolt is momentarily withdrawn by the engagement of inclined surfaces and the pipe moves downwardly the distance of one tooth. The quantity of fuel charged at each stroke is regulated by adjusting the distance between a pin projecting from the shaft and an abutment on an arm loosely mounted on the upper end of the shaft. The end of the arm is formed with a member adapted to bear against a cam ring, carried by the cap which is rotatable on the pipe to obtain the desired adjustment of the abutment with respect to the pin. The hopper is filled with fuel to a height equal to that of the teeth, so that the tube, on reaching its lowest position, serves to indicate that the hopper is empty; in addition, a signal device may be provided.

Furnaces. GEWERKSCHAFT SACHTLEBEN AND J. KÜPPERS. Brit. 286,590, May 2, 1928. In the furnace described the walls of the inner muffle are formed of materials of good thermal conductivity, such as silicon carbide, chromium silicide, molybdenum carbide, or mixtures of these materials, while the outer lining is of material of poor conductivity.

Coke ovens. R. E. ELLIS. Brit. 286,776, May 2, 1928. In a coke oven the horizontal partitions in the regenerators are omitted and the air is directed vertically through the checker-work. Preferably a horizontal air admission flue, having ports, which may be graduated in size according to their position in respect to the taper of the oven, is provided in the floor of each regenerator, and at their upper ends the regenerators communicate through short ports with the heating-flues.

Retort furnaces. R. W. BROADHEAD. Brit. 286,835, May 2, 1928. The producer of a gas-retort setting is arranged externally to and independently of the setting, the space in the setting which it would otherwise occupy being devoted to extension of the regenerator which is arranged to preheat both the producer gas and the secondary air or either of them. The regenerator instead of being confined to the area of the setting may extend to one or both sides thereof. The main flue may be sunk below ground level.

Retorts. C. HOLLANDER AND GIBBONS BROS., LTD. Brit. 286,846, May 2, 1928. Apparatus for receiving coke discharged from horizontal retorts and delivering it either

to the furnace or producer or to an incline leading to a quenching bench, comprises a receiver mounted so that it may be rocked about a shaft which is disposed below the receiver and supported in a frame. The latter carries a motor and gearing for operating the shaft and is suspended by ropes within a vertical framework, a second motor being provided to actuate the ropes and so bring the receiver into position to receive coke from any desired tier of retorts. The framework is mounted on wheels and is adapted to be traversed on rails in front of the retort battery. The receiver has converging walls at each end, and the rear end may be fitted with a removable baffle to prevent accidental discharge.

Furnaces. K. HUFSCHMIDT. Brit. 286,940, May 2, 1928. In a powdered fuel furnace primary air is injected in a direction tending to project the flame on to those parts of the wall on which slag collects, and secondary air is normally injected at a lower level in a substantially opposite direction so as to repel the flame from these parts; the slag is melted at intervals by interrupting the secondary air supply and simultaneously introducing an additional supply at a higher level, so as to allow the flame access to the slag.

Kilns. E. SOBEK. Brit. 286,956, May 2, 1928. A kiln charging-hopper is extended at one side to form a slide for the charge, this slide coöperating with a bulging portion on the opposite side of the hopper to effect the introduction of the charge into the kiln in layers. The hopper is supported by lugs on girders and is bolted, at its lower end, to a downwardly flared shoot which is formed with lugs engaging over girders. A hinged cover may be provided.

Furnaces. ASKANIA-WERKE AKT.-GES. VORM. CENTRALWERKSTATT DESSAU AND C. BAMBERG-FRIEDENAU. Brit. 286,977, May 2, 1928. In the burner for Cowper stoves or similar intermittent air heaters the gas and the air for combustion are both supplied under pressure by concentrically arranged nozzles. The gas supply pipe controlled by a valve leads to an annular nozzle surrounding a conical air supply pipe open to the atmosphere. Into the pipe project nozzles supplying air under pressure from a box, the jets also drawing in air from the atmosphere, and a fan driven by a motor may be fitted to accelerate the air flow. The nozzles and burner tube are formed as a Venturi tube so that a preponderance of either fluid may operate to draw in more of the other fluid. A slide valve is arranged at the narrowest part of the pipe and is pressed against a seat by the pressure of the air being heated by the apparatus, and any air escaping past this valve passes freely into the atmosphere and cannot enter the gas conduit.

Furnaces. ASKANIA-WERKE AKT-GES. VORM. CENTRALWERKSTATT DESSAU AND C. BAMBERG-FRIEDENAU. Brit. 287,132, May 9, 1928. In furnaces provided with a number of separate fuel-feeding devices, the air supplied to the furnace is regulated in accordance with the total amount of fuel supplied. Coal dust is fed to a common combustion chamber from 3 burners by means of screw conveyers. The spindles of the conveyers are coupled to 3 fans, the delivery pipes of which are connected to a common pipe so that the amount of air flowing through the pipe is a measure of the total fuel supplied. Pipes are connected to the pipe on opposite sides of a constriction and lead to opposite sides of a diaphragm. The movements of the diaphragm are transmitted to a pivoted jet pipe to control the supply of fluid through pipes to opposite sides of a piston and to operate the valve in the air supply pipe. The invention may be applied to furnaces with traveling grates or liquid fuel supply. Liquid pumps may be substituted for the 3 fans.

Coke ovens or gas retorts. PINTSCH AND OTTO GES. Brit. 288,337, May 31, 1928. The excess gas pressure in the lower part of freshly charged coke ovens or vertical retorts is relieved by connecting the ovens through pipes between which are valves so that the

high gas pressure in one oven is relieved by the passage of gas through the pipes to another oven in which the charge has been nearly completely coked. When the coking of the fresh charge has proceeded to a certain extent the valve to the particular oven is closed so that each chamber is again working independently of the others.

Kilns. J. AND J. W. MOSS. Brit. 288,383, May 31, 1928. A kiln for firing brick, tile, etc., is provided around its periphery with two series of fireplaces alternating with each other, one series being adapted, by the provision of flues behind the bag-wall, to fire the kiln from the top, while the other series communicates with openings in the bottom of the wall, the gases passing upwardly into the kiln through the perforated floor. The waste gases escape to the outlet flue through an open-topped conduit which extends to about one-half the height of the kiln and is formed with perforations near its upper end. The flues gradually increase in cross-sectional area upwardly and are formed with mid-feathers at the upper ends, while the flues leading from the second series of fireplaces to the openings are supplied with air through passages which extend to the outside of the kiln and serve also as inspection holes.

Furnaces. M. HERZFELD. Brit. 288,417, May 31, 1928. A traveling grate driving device in which the chain wheel shaft is driven at both ends, comprises a main driving shaft driving the shaft at one end through worm gearing and transmitting motion to the other end of the shaft through an auxiliary shaft, bevel gear, and worm gear.

Gas producers. O. MISCH. Brit. 288,426, May 31, 1928. In a process for generating water-gas from bituminous fuel, the lower end of the preliminary distillation retort is heated externally by a compressed air water-gas burner provided with baffles for producing eddying or turbulence or by oil or coal dust burners or similar means, so as to effect an intensive local heating of the contents of the lower portion of the retort to more than 700°C, the temperature decreasing toward the charging hopper to about 250°C. The upper end of the retort which comprises two shafts is supported on masonry by means of elastic sheet iron plates. During the "blow," air is supplied through a pipe, combustion gases escaping through a dust chamber and combustion chamber into heating flues of the retort and thence through a waste heat boiler and chimney. When steam is admitted through a valve, the air valve and a register between the chamber and dust chamber are closed, and the water-gas produced rises through the retort, passing with illuminating gas through a pipe. The register may be left open for a while after the air valve is closed and a small amount of steam admitted so that residual carbon dioxide and nitrogen are passed into the chimney. Part of the water gas produced is fed to the burner through a pipe together with compressed air through a pipe. Tar or tar oil may be injected into the retort if coke is not required through pipes by means of steam supplied through a pipe.

Furnaces. H. KLAGES. Brit. 288,459, May 31, 1928. A traveling grate has arranged at the sides vertically reciprocating bars actuated by projections. The bars are supported on a water-cooled bar and arranged beneath a channel iron supporting a cooling member which protects the brickwork. The front flange of the channel iron prevents lateral movement of the bars and serves as an air closure. Members support the channel iron and one member which carries the bars. The side brickwork is separated from the grate by an air space.

Furnaces. A. W. BENNIS. Brit. 287,255, May 9, 1928. A steam generator furnace is provided with a damper-controlled flue in the arch for carrying the gases from the front of the furnace to the combustion chamber where the draft is greater than at the rear of the grate and with grate bars having inclined air ports adapted to direct air in a forward direction toward the incoming fuel. The arch, front, and rear walls of the furnace are provided with air passages for cooling purposes. The side walls of the furnace are provided with water or steam tubes also for cooling purposes. The grate

may be provided with links having air ports, the outer ends of which are inclined forwardly while the rear ends pass around the pivotal centers of the links. Grooves and lateral air spaces may be provided on the sides of the links. A modified form of arch with damper-controlled flue is described. The draft through the flue in the arch may be assisted by a fan or other inducing means.

Furnaces; burners. P. St. G. Kirke. Brit. 287,291, May 9, 1928. In a gas-fired boiler in which combustion occurs within the boiler tubes, each supplied with gas by a separate jet or a set of jets, the maximum velocity of gas flow occurs at a restriction situated between the gas valve and the set of jets. The burner may comprise a header with branch pipes, each of which carries the jets corresponding with a row of boiler tubes, the restriction being a perforation in a diaphragm secured by bolts between flanges at the inlet-end of the header. On releasing the bolts the diaphragm may be removed for cleaning.

Carbureted water-gas plant. Humphreys and Glasgow, Ltd. Brit. 287,870, May 23, 1928. Automatic oil control for a carbureted water-gas plant comprises a calorimeter to measure the calorific value of the carbureted water-gas produced and a galvanometer system responsive to the calorimeter and balanced at the standard calorific value of the gas, but unbalanced and operative, upon departure from that calorific value, to vary the oil supply to the carburetor. Water-gas from the generator passes to the carburetor, the carbureted gas leaving a relief holder by a pipe from which a sampling pipe leads to a burner to which combustion air is supplied by an inlet. Heat is absorbed from the burner by air admitted through an opening and discharged through an outlet, resistance thermometers being placed in the air inlet and outlet, the difference indicating the calorific value of the gas sample. These thermometers form two legs of a Wheatstone bridge, the other two legs being resistances with a standardizing resistance for balancing at zero a galvanometer. A resistance wire on a drum is connected in variable proportions with the thermometers, and a battery supplies current for operating the galvanometer, which is deflected to the right or left according to the temperature difference between the thermometers. A motor drives continuously a shaft carrying cams, and when the galvanometer pointer is deflected to the right or left these cams are brought into operation to actuate a clutch which engages with a disk and moves it to a new position. On the shaft of the clutch disk is also mounted the resistance drum so that movement of the disk turns the slide wire drum and changes the proportion of the slide wire in series with the thermometers, and tends to return the galvanometer to zero where it remains until the next change in temperature is indicated by the two thermometers, when the operation is repeated. A pen attached to the disk records on a paper a line showing the calorific value of the gas. A cam on the shaft on rotation of the disk when the gas sample is above or below normal, is moved to operate finger switches which control the circuit from a line switch and actuates by solenoids, valves, which in conjunction with a hand operated valve control the oil supplied to the carburetor by the pipe. Modifications in the means for actuating the oil value are also described.

Coke ovens. C. Otto & Co. Brit. 287,885, May 23, 1928. To provide an unobstructed outlet for the distillation products from a coke-oven charge the gas-collecting space near the discharge outlet of the oven is increased either by suitable construction of the chamber roof or by disposition of the surface of the charge or by both methods. The chamber roof may be reduced in depth between charging openings and toward the gas outlet. The cross-section of the levelling ram may correspond to the tapered form of the roof so that the rod has a greater resistance to bending than usual. The gas outlet may be arranged at the center of the chamber, the roof being tapered toward the center.

Vertical retort furnaces. J. Pieters. Brit. 287,934, May 23, 1928. In a continuous vertical distillation retort furnace the long walls of the retorts are formed by

refractory tubular elements jointed together both horizontally and vertically and forming the heating flues. At their upper ends the flues are connected by horizontal collectors, delivering to a flue. A central notch at the upper end of each tubular element receives a baffle brick, and the base elements are formed with an additional central conduit dividing the element into conduits to which gas and air respectively are supplied and thus preheated prior to combustion. Further recuperation of heat is obtained by the circulation in base channels of steam which is introduced into the retorts toward the base through holes, in the short sides. Apertures higher up in the short sides provide for the escape of distillation products. The charge is supplied from hoppers past flaps which are oscillated from time to time to keep the material moving and when horizontal form, in conjunction with the hopper contents, an adequate closure. At the base, oscillating valves mounted on shafts in the plane of the longer axis of the chamber tend to accelerate the descent of the material adjacent the walls.

Vertical retorts. J. PIETERS. Brit. 287,935, May 23, 1928. The lower end of a vertical coking-retort is provided with a water-sealed closure device comprising a gutter adapted to coact with a downwardly-extending flange on a slidable closing member which, when the retort is to be discharged, is first raised to break the seal and then withdrawn horizontally to uncover the discharge opening. The gutter is formed at the lower end of a casing which surrounds the base of the coke-receiving hopper and is extended at one side to form a housing for the slide when in its open position. To the side walls of the casing are secured rails which are downwardly inclined at the ends and are engaged by rollers on the slide, the latter being connected to a pull-rod on operation of which the slide is first raised at its inner end to free the flange from the gutter and is then withdrawn horizontally into the housing. Coke is prevented from entering the seal by a flap which is freely suspended in vertical guides so that it may be raised by the slide during withdrawal. Discharge of coke from the retorts into the hopper is controlled by a segmental door which is formed with side cheeks pivoted, and is telescopically arranged in relation to a correspondingly curved extension secured to the lower end of the retort.

Rotary kilns and coolers. O. BOUZIN. Brit. 288,114, May 23, 1928. In the cement kiln apparatus, an annular projection is fitted at the end of the high temperature zone of the kiln, and projections are fitted in the cooler, those at the hotter end being of refractory material, and those at the cooler end of metal.

Smokeless fuel. CHEMISCH-TECHNISCHE GES. Brit. 288,235, May 31, 1928. Fine-grained or dustlike anthracite or lean coals, or such coals in small pieces are mixed with bituminous fuel and subjected to heat to form smokeless fuel in coarse lumps. Low temperatures, *e.g.*, 500–600°C or higher temperatures, *e.g.*, 1000–1200°C may be employed. In an example 100 kg. of fine-grained anthracite are mixed with 35 kg. of a swelling coal containing 30% of volatiles and distilled in a stationary layer about 10 cm. thick at about 500–600°C. In another, 100 kg. of fine-grained lean coal having 12% of volatiles are mixed with 30 kg. of bituminous coal and heated at temperatures of 450–1000°C. The mixture may be distilled in a number of horizontal cells provided with conveyer worms which effect a uniform stratification of the fuel, and gas and tar may be recovered.

Coke. CHEMISCH-TECHNISCHE GES. Brit. 288,264, May 31, 1928. In a method of producing semicoke with ash of a desired composition, the fuel is mixed with fluxes of such a nature that during heating no chemical reaction takes place between the fluxes and the original ash constituents. Suitable additions are oxides of iron, aluminium, or manganese. The desired composition of the ash may be obtained by mixing several types of fuel, *e.g.*, siliceous and calcareous coals. Fluxes are used which favorably affect the yield of tar. Distillation takes place at about 500–700°C.

Steam boilers and furnaces. SIEMENS-SCHUCKERTWERKE AKT.-GES. Brit. 288,298, May 31, 1928. In a boiler having nests of generating tubes lining a vertical combustion chamber, the gases pass from the bottom of the combustion chamber upwardly through side flues of rectangular cross-section containing superheaters and air heaters. The spaces between the supporting columns are closed by air-heating casings, which may be removed to facilitate the withdrawal of the generating tubes, the superheaters, and the air heaters. Air is drawn down through the casings by a fan and then forced up through the casings to the air heaters, from which it passes into the combustion chamber through nozzles projecting from distributing chambers. The furnace gases pass through filters on their way to the chimney. The furnace crown is suspended from a platform and can be lifted up upon the platform after removing the air and fuel supply pipes.

Gas manufacture. W. SCHWEDER. Brit. 288,336, May 31, 1928. In a process of producing a mixture of coal-gas and water-gas, the glowing coke from the coke oven is transferred to a water-gas generator in which it is gasified. The hot coke discharged from the distillation chamber is conveyed in trucks to a water-gas producer to which steam is admitted by a pipe. The water-gas passes by a pipe to be mixed with the distillation gas. The generator for heating the chamber is charged with coke and fed with a part of the water-gas. The coke in the generator may be periodically blasted up with air when a greater supply of water gas is required, and the entire charge of coke may be consumed in this way. The gases from hot blasting are cooled and used to dry-cool the coke in a container, and the gases thus reheated are passed through a waste-heat boiler to a chimney. The heat of the hot blast gas may also be used for generating steam in a waste-heat boiler, the discharge end of which communicates with the coke container by a pipe. The steam from the boilers is used in the water-gas generator. A recuperator is provided by which the hot blast gas is used to preheat the water-gas supplied to the generator, the water-gas being heated in channels by the hot blast gas in channels. The water-gas entering the generator may also be heated directly by admixing it with the hot blast gas from pipe.

Retorts for distilling fuel. R. W. EASTON. Brit. 288,700, June 7, 1928. A retort for the distillation of lignite or other carbonaceous material is divided into chambers by longitudinal partitions which act as conductors of heat into the charge. The steam is withdrawn from the top only through outlets, other outlets having openings underneath are provided for the remaining distillates.

Geology

Definition and application of greenstone. ANON. *Ceram. Ind.*, **10** [6], 620 (1928).—Greenstone or diabase is understood to be a volcanic rock more recent than basalt and older than lava and slag. The composition may be considered similar to feldspar, *i.e.*, mixed silicates of alkalis, earth alkalis, magnesia, clay, and usually with iron protoxide. It is characteristic that the alkali in greenstone is usually carbonate of soda, in contrast to most feldspars which are as a rule potash-bisilicates. Therefore diabase is often also termed a carbonate of soda feldspar. This carbonate of soda content together with the high iron content effects a much more intense fusibility of the greenstone than ordinary feldspar. The iron is as a rule a ferro-silicate which causes the peculiar colorings of the greenstone glazes. It is impossible to give an accurate and constant formula since the composition of volcanic stone always varies somewhat. With reservations the formula may be stated: Na_2O 0.7, Al_2O_3 0.3, Fe_2O_3 $6SiO_2$. The analysis of an average sample of Silisian greenstone showed: 47.8% silicic acid, 18.5% clay, 1.7% iron oxide, 11.0% iron protoxide, 4.9% magnesia, 10.0% lime, 3.2% potash, 2.9% ignition loss.

F.P.H.

Diamond-core drilling and underground mining in nonmetallic fields. L. D. COOPER. *Rock Prod.*, **31** [11], 34–35 (1928).—A thorough diamond drilling of the property will yield 3 essential facts: (1) the quantity of marketable material may be readily computed from the area and thickness of beds or strata; (2) the quality of material and its adaptability to specific uses is revealed by physical and chemical tests of the rock cores; (3) the question of mineability can be answered by a study of the facts of physical distribution of the material and the dip of the strata. In addition to securing these data of primary importance, diamond-core drilling provides a means of economical and rapid prospecting when scouting around for stone for some specific purpose. It is equally valuable in blocking out stone and keeping reserves in proper relation to production. When tracts are optional as potential reserves, the value of these lands may be determined by drilling so that those which are barren may be disposed of, thus eliminating the payment of unnecessary taxes. F.P.H.

Geology and economic resources of the St. Peter sandstone of Illinois. J. E. LAMAR. Ill. State Geol. Surv., *Bull.*, No. 53, 175 pp. (1928).—This report is a comprehensive study of the St. Peter sandstone as known in Illinois, the economic viewpoint being stressed. The stratigraphic relations, structure, general lithology, variations in texture and thickness, heavy mineral content, relative roundness of sand grains and sedimentary structures are described. More than 100 uses of sand are described, and the suitability of St. Peter sand discussed. The use of sand in the manufacture of clay brick, sand-lime brick, brick pavements, silicon carbide, cements, enamels, fused silica, glass, glazes, grinding wheels, pottery, refractories, sodium silicate, etc., is discussed as well as its use as banding, burnishing, molding, facing and placing sands, and in sand seals. A.E.R.W.

Texas potash bed. ANON. *Nat. Glass Budget*, **44** [5], 25 (1928).—Two potash beds that have a combined thickness of 6 feet 7 inches and together contain 12.86% of potash (K_2O) in the sample as received, equivalent to 18.98% in the soluble salts have been found by government tests in southwestern Ector County, Texas, in the interval between the depths of 1935 feet 7 inches and 1945 feet. E.J.V.

Bauxite in Morocco. ANON. *Chem. and Ind.*, **47,** 534 (1928).—A large bauxite deposit is reported by German investigators to have been discovered in the Atlas region of Morocco. Estimates place the quantity at 20 million metric tons, the quality being good. Water power is available locally. H.H.S.

Tyrrell endowment for study of Canada. ANON. *Chem. and Ind.*, **47,** 535 (1928).—J. B. Tyrrell, managing director of Kirkland Lake Mines, has set a precedent for the furtherance of scientific visitors to Canada. He has placed $10,000 in the hands of the Geological Society of England as an endowment to be known as the Tyrrell fund. The fund will be used by the Society to accord geologists the opportunity to come to Canada and study its geology and mining. H.H.S.

BOOK

Nonmetallic Minerals. Vol. 3, Edited by A. C. Fersmann. Mineral Resources Commission of the Academy of Sciences. U.S.S.R., 1927. 719 pp. 7.50 rubles. Reviewed in *Min. and Met.*, **9** [257], 250 (1928).—This volume is the third of a 4-volume set on the nonmetallic mineral resources of Russia. The great bulk of the publication is due to its discussing each mineral commodity from the physical, mineralogical, geological, and economic point of view; the principal foreign deposits as well as the Russian ones are included. Each chapter concludes with a selected bibliography. It will be a useful source of reference for those who read Russian, or are interested enough to have it translated. F.P.H.

Chemistry and Physics

Adsorption at crystal-solution interfaces. III. Individual macroscopic ammonium alum crystals grown in the presence of gelatin and dyes. G. W. BENNETT AND W. G. FRANCE. *Jour. Amer. Ceram. Soc.*, **11** [7], 571–81 (1928).—The present work is a continuation of the study of adsorption processes at solution crystal interfaces. It consists of an investigation of the adsorption of dyes, gelatin, and amino acids by the various faces of ammonium alum. The growth ratios of this alum were measured both in the presence and absence of these foreign substances. Adsorption was found to occur only at the cube faces and to be specific in character. The effects obtained are explained on the basis of residual valencies, polar groups in the absorbed material, and the interionic distances in the crystal lattice. The extension of these ideas to the study of the flocculation of suspensoid sols has been suggested. The growth ratio V_{100}/V_{111} for pure ammonium alum was found to be 1.53.

The use of 8-hydroxyquinoline for the chemical analysis of silicates. JOSEF ROBITSCHEK. *Jour. Amer. Ceram. Soc.*, **11** [7], 587–94 (1928).—A method for the gravimetric and titrimetric determination of different metals, devised by Berg, is used for the analysis of silicates. Alumina and magnesia are precipitated with 8-hydroxyquinoline and the precipitates can be either dried and weighed or dissolved and titrated. Both metals can be determined in the presence of silica and thus much time is saved, if determination of the silica is not required. For different purposes different methods have been devised and very accurate results have been obtained.

Limits of inflammability of gases and vapors. H. F. COWARD AND G. W. JONES. Bur. Mines, *Bull.*, No. 279, 99 pp. (1928).—This work was undertaken in connection with the Bureau's study of problems relative to the safety of coal miners and the utilization of fuels, and covers the inflammability of the gases that are found in mines or are produced for industrial purposes. An inflammable mixture of gases, such as methane and air may be diluted with one or the other of its constituents or with other gases until a composition is reached which is no longer inflammable. The dilution limit of inflammability, or simply the limit of inflammability, is the border line composition; a slight change in one direction or the other produces a mixture which is accordingly inflammable or noninflammable. There are clearly two limits of inflammability, a higher and a lower, for each pair of so-called combustible gas and supporter of combustion. The lower limit corresponds with the minimum amount of gas, the higher, or upper limit with the maximum amount of gas capable of conferring inflammability on the mixture. The experimental determination of limits of inflammability is more difficult than may be anticipated, as is shown by the contradictory figures reported from time to time. It is the object of this paper to present results of a critical review of all figures published on the limits of inflammability of combustible gases and vapors when in admixture with air, oxygen, or other atmosphere. Suspended dusts and liquid mists are not considered. The study describes the procedure followed with respect to (1) source of ignition, (2) direction of flame propagation, (3) diameter and length of vessel used, (4) effect of small changes in atmospheric composition, (5) pressure, (6) temperature, (7) turbulence and limits in air compared with limits in oxygen. Experimental results are given with various mixtures of gases including hydrogen, ammonia, hydrogen sulphide, carbon disulphide, carbon monoxide, methane, ethane, propane, butane, pentane, ethylene, acetylene, benzene, toluene, methyl alcohol, ethyl alcohol, ethyl ether, acetadehyde, acetone, methyl ethyl ketone, ethyl formate, methyl acetate, ethyl acetate, ethyl nitrite, dichlorothylene, pyridine. A very complete bibliography is given. R.A.H.

Measurement of surface tension. N. ERNEST DORSEY. Bur. Stand., *Sci. Paper*, No. 540, 32 pp. (1928).—This paper presents (1) a brief survey of the more important methods which have been employed in the measurement of surface tension, (2) some

of the more important facts which lead to success in such measurements, (3) certain errors which are frequently made and how they may be avoided, and (4) the working equations that are applicable to the methods considered. A bibliography of more than 100 selected papers is appended. In each instance the reason for selecting the reference is indicated. R.A.H.

Increased production of borax. ANON. *Ceram. Ind.*, **10** [6], 606 (1928).—Within the past few years there has been a marked development in the production of natural borax occurring in brine and today between 40,000 and 50,000 T. of borax per year (nearly $^1/_2$ the world's consumption) are made from brine in one plant at Searles Lake. Another important source of borax has been discovered in the U. S. in a mineral called rasorite which is $Na_2B_4O_7 \cdot 4H_2O$. It will be noticed that this mineral is essentially borax, but it contains only 4 molecules of water instead of 10. It requires only purification and recrystallization to make it marketable. It seems reasonable to suppose that these 2 natural sources of borax, *i.e.*, borax brine and rasorite will eventually account for the larger part of the world's production to the exclusion of such products of colemanite, pandermite, and ulexite, which require considerable chemical treatment to convert them into borax. It is likely also that the struggle for supremacy between these two sources, borax brine and rasorite, will materially cheapen the price of borax and possibly place it in the list of heavy chemicals with the resultant large increase in its world consumption. F.P.H.

Some complex copper silicates. A. DUBOIN. *Compt. Rend.*, **186,** 234–35 (1928).—A small quantity of blue prismatic crystals associated with crystals of a bluish tint approaching violet and with perfectly crystallized black, weakly transparent crystals of CuO were obtained by fusing K_2F_2 in a platinum crucible over a Meker burner, dissolving SiO_2 and then CuO in the bath, cooling, adding an excess of KCl, and then reheating while maintaining the bottom of the crucible at a higher temperature than the upper surface. Upon cooling the crystals were formed. The blue prismatic crystals had a density of 2.87 at 0°C and were readily attacked by HCl. Their chemical composition corresponded to the formula $K_2O \cdot CuO \cdot 4SiO_2$. By adding Al_2O_3 and then CuO to a molten bath of K_2F_2 in which SiO_2 was dissolved, cooling, reheating, adding an excess of KCl, and cooling slowly a fused mass containing crystals was obtained. The crystals recovered from the residue after solution with H_2O were leucite and small blue prismatic needles. The latter had a density of 2.8 at 0° and were readily attacked by HCl. Their chemical composition corresponded to the formula $3K_2O \cdot 2CuO \cdot Al_2O_3 \cdot 6SiO_2$. H.I.

Preparation of hydrated barium oxide from the carbonate. PAUL BAUD. *Compt. Rend.*, **186,** 438–41 (1928).—An intimate mixture of $BaCO_3$ (100 parts) and Fe_2O_3 (12 to 15 parts) held at 1150–1180°C for $1^1/_2$ hours in a tube furnace gave a black product containing 56–58% BaO which slaked in contact with water evolving considerable heat. The experiments were varied by adding $CaCO_3$ to make the mass more porous or light, magnesia or chromite to alter the time or the temperature of heating. Using a rotary furnace on a semi-industrial scale with a mixture of precipitated $BaCO_3$ and colcothar even better yields of BaO were obtained than in the tube furnace. The possibilities of the rotary furnace in preparing BaO to be used as a concentrated liquor in precipitating saccharose retained in the molasses of sugar refineries and in the industrial manufacture of alkalis and of precipitated $BaSO_4$ are pointed out. H.I.

Introduction of bromine and iodine into silicates. A. DUBOIN. *Compt. Rend.*, **186,** 762–64 (1928).—Double bromo- and iodo-silicates of Co and K were made by treating CoO with fluorhydrate of potassium fluoride in a platinum evaporating dish. The product of the reaction with K_2F_2 and SiO_2 was heated for several hours in a platinum crucible, cooled, an excess of KBr or KI added and the mass left over a Meker burner for 2 or 3 days. The crystalline materials are obtained as a residue after solution in water. The salts have the following properties:

Formula	Density at 0°C	Mean index of refraction
$KBr \cdot K_2O \cdot CoO \cdot 4SiO_2$	2.80	1.540 ± 0.003
$KI \cdot K_2O \cdot CoO \cdot 4SiO_2$	2.95	1.572 ± 0.003

The corresponding chlorosilicate (*Compt. Rend.*, **172,** 972(1921) has the mean index 1.505 ± 0.003. All three are weakly birefringent. H.I.

Effect of nonuniformity and particle shape on average particle size. HENRY GREEN. *Jour. Franklin Inst.*, **204,** 713–29(1927).—The question of the measurement of average particle size is affected by the definition of this term. The effect of nonuniformity on particle size where only the simplest shapes occur is investigated in the first part of the paper while the second part goes in detail as to the effect of shape on particle size in nonuniform materials. It was concluded that there is no general average particle size but that particle size must be given as some general average diameter selected according to the use, that nonuniformity introduces no insurmountable difficulty provided there is a geometrical similarity of particles and that the natural diameter of a single particle is six times the volume divided by the surface area. In the second part dealing with the effect of shape on uniformity, the use of formulas of the average diameters obtained on the basis of geometrical similarity is adopted for all cases of geometrical dissimilarity. Formulas for mixtures covering all cases are given. The practical application of the work is discussed. J.T.L., JR.

Physico-chemical properties of Japanese acid clay. II. Heats of wetting acid clay, fullers' earth, and Florida earth. K. KOBAYASHI AND K. YAMAMOTO. *Jour. Soc. Chem. Ind., Japan,* **31** [5], 101B–102B(1928).—The heats of wetting by water of Japanese acid clay, fullers' earth, Florida earth, kaolin and animal charcoal have been determined by an electrical calorimeter. The results obtained are as follows:

Samples	Heats of wetting (cal/g)
Fullers' earth	21.03
Florida earth	16.75
Japanese acid clay (from Itoigawa)	12.51
" " " (from Odo)	11.14
Kaolin ("Gairome")	5.84
Animal charcoal (Merck)	5.72

These heats are generally greater than those of kaolin and animal charcoal. In the previous report (see *Ceram. Abs.*, **6** [10], 470(1927)) it was reported that Japanese acid clay is composed of much smaller particles compared with other clays and their radii have been calculated to be between 1×10^{-5} and 2×10^{-5} cm. Parks has shown by special experiments that the heat of wetting is proportional to the area of the boundary surface. The authors consider that the heat of wetting by water of Japanese acid clay is due to the large surface area of it. **III. Heats of polymerization of turpentine oil, α-pinene by Japanese acid clay, fullers' earth, and Florida earth.** *Ibid.*, 102B–103B.—The heats of polymerization of turpentine oil or α-pinene with Japanese acid clay, fullers' earth, Florida earth, silica gel, kaolin and animal charcoal were determined by electrical calorimeter. The samples were dried at 150°C for 60 minutes. The results are as follows:

Heats of Polymerization of Turpentine Oil
(Sp. gr. 0.8575 at 23.5°C)

Samples	Heats of polymerization (cal./g)
Japanese acid clay (Itoigawa No. 1)	1623.6
" " " (" No. 2)	807.7
" " " (" No. 3)	418.6
" " " (Odo)	60.2
Florida earth	48.8
Kaolin (Gairome)	19.0
Silica gel	27.4
Animal charcoal (Merck)	21.3

Heats of Polymerization of α-pinene
(B.p. 155–56°C, sp.gr. 0.852 at 30.3°C, ref. index 1.4612 at 30.3°C)

Samples	Heats of polymerization (cal./g)
Japanese acid clay (Itoigawa (No. 1)	2065.8
" " " (" No. 2)	2154.2
" " " (" No. 3)	1894.1
" " " (Odo)	38.8
Silica gel	28.8

In another series of measurements, the heats of polymerization of turpentine oil were determined with the above mentioned samples which had been dried for one hour (*a*) at room temperature, (*b*) at 98°C, (*c*) at 130°C. The heats of polymerization of those samples dried at higher temperatures were greater than those of samples dried at lower temperatures, and the difference is especially remarkable in the case of Japanese acid clay. The heat of polymerization of the sample from Itoigawa is much greater than that of the other Japanese acid clay (*e.g.*, Odo), fullers' earth, and Florida earth. It is very important to investigate the cause of this peculiar property of the Japanese acid clay (Itoigawa). E.J.V.

Application of the heating curve in obtaining hydrochloric acid and magnesium oxide by heating magnesium chloride. Y. KATO AND K. TACHIKI. *Jour. Soc. Chem. Ind., Japan*, **31** [5], 104B–106B (1928).—Investigations were carried on for determining the compounds which were formed by raising the temperature of hydrated magnesium chloride in a partially closed tube. In the investigation two methods were employed: (1) the decreasing weight of the sample during the rising temperature was determined by using Honda's "thermobalance," the weights at different temperatures being plotted against the temperatures, (2) the "heating curve" which was introduced by one of the writers for the purpose of tracing chemical changes at different temperatures, was obtained. It consists of determining the temperatures of the substance under investigation and temperature-differences of the same substance and a standard one, both substances being put in an electric furnace. Those temperature differences are plotted against the temperatures of the substance under investigation. By this method the temperatures at which chemical changes involving heat absorption or heat liberation take place are determined. From the figures obtained the following conclusions were drawn: (1) Four reactions begin to take place at the following temperatures:

	By thermo-balance	By heating curve
$MgCl_2\ 6H_2O \rightarrow MgCl_2\ 2H_2O$	150°C	150°C
$MgCl_2\ 2H_2O \rightarrow MgCl_2\ H_2O$	240	225
$MgCl_2\ H_2O \rightarrow 2MgCl_2MgO\ H_2O$	265	280
$2MgCl_2\ MgO\ H_2O \rightarrow MgO \cdot MgCl_2$	495	465

(2) Eschellman pointed out that $4MgCl_2 \cdot 2MgO \cdot 3H_2O$ was stable at 250–350°C, but K. and T. found $2MgCl_2 \cdot MgO \cdot H_2O$ was stable between 330–493°C. (3) The exothermic reaction at 350–505°C as pointed out by Moldenhauer (*Z. Anorg. Chem.*, **51**, 378 (1906)) was not confirmed, but it was found that very little chemical change, if any, took place in the temperature interval. E.J.V.

Precipitation of vanadium. B. S. EVANS AND S. G. CLARKE. *Chem. and Ind.*, **47**, 501 (1928).—The method is based on the precipitation of vanadium as ferrocyanide, and eventual determination by titration with $KMnO_4$. Vanadium ferrocyanide is insoluble in mineral acids of quite high concentration. Nickel if present interferes with the process; it should be removed beforehand by treatment with dimethylglyoxime. H.H.S.

Zirconia separation from compounds of tantalum and niobium. W. R. SCHOELLER AND E. F. WATERHOUSE. *Chem. and Ind.*, **47**, 501 (1928).—The pyrosulphate hydrolysis

method does not effect a quantitative separation of the earth acids from ZrO_2. At best, a decrease in the quantity of ZrO_2 co-precipitated is achieved, at the cost of a slightly incomplete earth-acid precipitation. The hydrolytic precipitation of TiO_2 from acid sulphate solution, and of earth acids in presence of TiO_2, is prevented by presence of ZrO_2. H.H.S.

The phenomenon of wetting. F. L. USHER. *Chem. and Ind.*, **47**, 552–56 (1928).—A symposium held at the Univ. of Leeds. U. discusses the principles underlying the phenomenon of wetting. He indicates the various factors which determine the angle of contact between a liquid and a solid surface and points out that our knowledge of wetting is limited through our lack of knowledge of the surface tension of solids. The subject is more complicated by the fact that wetting in industry is rarely, if ever, wetting by pure water, and also because the degree of dispersion of heterogeneous liquid systems is probably an important factor. Papers were read by Ritson on "Wetting as Applied to Mining," and by Bain, Speakman, and Thompson on "Wetting as Applied to Asphalt, Textiles, and Leather." H.H.S.

Sorption of vapors by fibrous and film materials. P. T. NEWSOME. Kodak Res. Lab., *Communication*, No. 343; *Chem. and Ind.*, **47**, 594 (1928).—The McBain-Baker quartz fiber spring balance has been found suitable for measuring sorption of vapors. The apparatus is described and illustrated. H.H.S.

Specific heats of amorphous carbon and semicokes. E. TERRES AND H. BIEDERBECK. *Gas u. Wasserfach*, **71**, 265–68, 297–303, 320–25, 338–45 (1928).—Three samples of amorphous carbon have been prepared, (*a*) by the action of sodium on barium carbonate at 550°, (*b*) by the action of chlorine on turpentine below 600°, and (*c*) by the catalytic decomposition of methane below 600°, and determinations made of the mean specific heat of each sample, over temperature ranges from 20–300° to 20–1200°. The method used is described in detail, all the precautions being taken necessary to insure accuracy. The results for all three samples of carbon were similar; the mean specific heat rose rapidly with the temperature (*i.e.*, the upper temperature of the range) up to about 600°, and thence only slightly to about 1150°, the value then agreeing with that of graphite. The values obtained at the lower temperatures were at first greater than the corresponding values for graphite, but after the carbon had been heated to 1200° the mean specific heats re-determined at the lower temperatures approximated closely over the entire range to those of graphite. Semicokes were prepared from four coals at temperatures from 400° to 900°, and their specific heats have been determined over ranges up to their respective temperatures of carbonization. The specific heat of each coke rises with the temperature and for cokes from the same coal is higher the lower the temperature of carbonization. The specific heat of the coke-substance of all the semicokes investigated over temperature ranges from 550° to 900° was constant and equal to 0.3825 ± 0.0025. Below 550° the specific heat is higher for semicokes from gas coals than from other coals. (*B. C. A.*)

Colorimetric determination of iron in water. P. LEHMANN AND A. REUSS. *Z. Unters. Lebensm.*, **54**, 374–76 (1927).—One hundred cc. of water are evaporated to dryness in a platinum basin, 5 cc. of a 10% potassium sodium carbonate solution are added to the residue, and the contents of the basin again brought to dryness. After drying at 170–200°, the residue is heated to dull redness. When cool it is dissolved in 5 cc. of 15% hydrochloric acid and solution transferred to a colorless glass cylinder with flat bottom. To the cooled clear solution, 1 cc. of a bromide-bromate solution is added, the mixture kept for 5–10 min., and treated with 5 cc. of a 7.5% ammonium thiocyanate solution. Simultaneously a blank test is carried out, to which a solution of iron ammonium alum of known strength is added from a burette until the colors of the two solutions are equal, both being brought to the same volume by addition of water. The

amount of iron in the sample is calculated from the volume of standard iron solution added to the blank. (*B. C. A.*)

BOOK

Cohesion and Related Problems. Faraday Society, London, 1928. 128 pages. Price 10*s* 6*d*. A general discussion held by the Faraday Society. H.H.S.

PATENTS

Preparing antimony sulphide. HANS NUHN AND LEWIS H. BLOOD. U. S. 1,671,203, May 29, 1928. The step in the method of making antimony pentasulphide which comprises atomizing by steam a solution of thio-antimoniate and of an acid gas.

Preparation of modified cellulose for manufacturing cellulose acetates. MAURICE CUSIN AND PIERRE ALPHONSE ANDRÉ CHEVALET. U. S. 1,671,513, May 29, 1928. A process of preparing a modified cellulose for use in the manufacture of cellulose acetates, comprising the step of immersing cellulose in a bath of formic acid of 80 to 90% strength to which concentrated sulphuric acid has been added.

Producing technical pure beryllium for freeing metallic beryllium from impurities. HELLMUT FISCHER. U. S. 1,673,043, June 12, 1928. The method of purifying impure metallic beryllium comprising mixing alkaline-earth-halogenide and alkali-halogenide, heating the mixed compounds until they are molten, and introducing the beryllium to be purified into the molten compounds.

Decomposing chromium ores. BOZEL-MALÉTRA SOC. INDUSTRIELLE DE PRODUITS CHIMIQUES. Brit. 288,250, May 31, 1928. The thermal decomposition of chromium ores with alkalis or alkaline reagents in the presence or absence of diluents is effected in a mechanical furnace of the type customarily employed in the roasting of pyrites, such furnace having one or more stages, being adapted for continuous working, and being provided with agitating means. The reaction mixture is distributed in thin layers during the heat treatment, which latter may be effected by the use of combustible material in contact with the mixture, or by the employment of externally heated muffles through which the mixture passes. The components of the mixture may be introduced separately into the furnace; and the temperatures used may be from 200–300°C less than those usually employed, whereby the recovery of the sodium chromate formed is rendered easier.

Barium sulphate. K. EBERS. Brit. 288,498, May 31, 1928. Crude heavy spar of the kind that is free from or poor in lime but contains such impurities as silica and iron and manganese compounds is roasted at a temperature which preferably does not exceed its sintering point, treated with water, as by quenching, and then with an acid such as hydrochloric acid, whereby a pure white product is obtained, which may be washed and ground.

Treating titanium ores. TITANIUM PIGMENT CO., INC. Brit. 288,569, June 7, 1928. A readily soluble mass is obtained from titaniferous materials by treatment with a solvent such as concentrated sulphuric acid under such conditions that gases or vapors, evolved *in situ* or externally introduced, are present in the interior of the reacting mass, no external heat being applied during the course of the reaction. The course of the reaction may be controlled and the porosity of the product be increased by agitating the mass during the reaction, as by the injection of air or other gases or by mechanical means, and if necessary the reaction may be initiated by adding a small quantity of water to the mixture, with or without preheating of the latter to 50–160°C and preferably to 80–120°C, as by the injection of steam. Water may also be added from time to time during the reaction to maintain the desired temperature. The reaction product may be leached with water, or with dilute acid such as wash liquors or the liquor remaining after hydrolysis of the solution obtained, and the resulting solution be treated, as by

immersing therein lead baskets containing iron or zinc, to reduce ferric iron and some tetravalent titanium to obtain a solution suitable for hydrolysis. An example of the treatment of ilmenite with sulphuric acid is given.

Contact sulphuric acid process. SELDEN CO. Brit. 286,708, May 2, 1928.—A contact mass for oxidizing sulphur dioxide to trioxide comprises a catalytically ineffective base exchange body physically combined with a catalyst. The base exchange body may be a zeolite comprising silicates of two or more metals, of which one or more may be a heavy metal, *e.g.*, aluminium, beryllium, cadmium, zirconium, zinc, titanium. The catalyst may be a metal of the 5th or 6th group such as vanadium, molybdenum, tungsten, uranium, chromium, manganese, arsenic, antimony, tantalum, niobium, bismuth; with or without the addition of an activating ingredient such as manganese. beryllium, aluminium, titanium, iron, copper, zirconium, zinc, lead, silver, cerium, nickel, cobalt, boron, and the rare earths. Platinum and vanadium compounds are particularly effective catalysts; the vanadates and vanadites of iron, copper, silver, nickel, cobalt, titanium, zirconium, cerium, aluminium, calcium, cadmium, uranium, chromium, and manganese are specified. The catalyst and the base exchange body may be combined in any suitable way, *e.g.*, by mechanical mixing, by mixing the catalysts or substances which react to produce them, with the solutions from which the zeolite is formed, or with the zeolite in the gel stage, or by impregnating the prepared zeolite. The combined bodies may be further treated with salt solutions or with acid compounds which cause the formation of such, to introduce bases in exchangeable form which have an activating or stabilizing effect on the catalyst. Diluents such as kieselguhr, talc, slag, silica gel, graphite, porcelain, or metal powders may be incorporated with the contact body; a porous mass can be obtained by incorporating substances subsequently removable by solution or calcination. The contact body may be affixed to massive carriers, *e.g.*, granulated metals, metallic oxides, and siliceous substances.

Silica and metal oxide gels. SILICA GEL CORP. Brit. 287,066, May 2, 1928. Hard, tough, low-density gels of silica, tungstic acid, alumina, titanium oxide, or mixtures of these substances, are prepared by submitting the hydrogel to a heat treatment prior to drying. The treatment is effected by heating the hydrogel slowly to 175–325°F under conditions which prevent dehydration, and slowly cooling it. The hydrogel may be washed before or after the treatment or the dried gel may be washed. The treatment may be carried out by passing heated gas or vapor saturated with water vapor over the hydrogel, by heating the hydrogel immersed in water in an open or closed vessel, by circulating heated air repeatedly over the hydrogel while on perforated trays in a drying chamber, or by soaking the washed hydrogel in strong sulphuric acid which reacts with the water to produce rise of temperature.

Zirconium oxychloride. RHENANIA-KUNHEIM VEREIN CHEMISCHER FABRIKEN AKT.-GES. Brit. 287,424, May 9, 1928. The product obtained by sintering zirconium ores in admixture with lime and an alkaline-earth halide, is treated with hydrochloric acid of such a concentration that a solution which in the cold is almost saturated with calcium chloride results, whereby a high yield of zirconium oxychloride crystals is obtained. Preferably, to avoid precipitation of the oxychloride while filtering the hot solution, insufficient hydrochloric acid to transform all the bases present to chlorides is used, the solution obtained separated from insoluble constituents, and further hydrochloric acid then added to precipitate the oxychloride. In an example, using hydrochloric acid of 19° Bé, 85% of the amount of acid necessary to transform all the bases to chlorides is used, whereby a solution is obtained which can be cooled to 20°C without depositing crystals. After filtration, the remaining 15% of acid is added to the liquor, causing precipitation of the oxychloride. If, however, the whole of the hydrochloric acid is employed for the purpose of obtaining the solution, crystals of the oxychloride separate out at 70°C.

General

Silica in relation to industry. J. A. BENNELL. *Min. and Met.*, **9** [257], 288–89 (1928).—The common uses of silica in industry may be classified about as follows: (1) Chemical industries: filtering medium, manufacture of silicon carbide, manufacture of water-glass. (2) Paint: inert extender. (3) Mineral fillers: wood filler, filler in rubber, hard rubber, pressed and molded goods, phonograph records. (4) Ceramic uses: glassmaking, ingredient of porcelain, ingredient of bodies and glazes. (5) Insulation: sound insulation in walls, between floors, etc. (6) Structural materials: sand-lime brick, concrete mortar. (7) Optical quartz: manufacture of lenses and accessories for optical apparatus. (8) Abrasives: scouring and polishing, soaps and powders, sandpaper, sand-blast work, sawing and polishing marble, granite, etc., tube-mill grinding pebbles, tooth powders and pastes. (9) Refractories: silica fire brick and other refractories. (10) Metallurgical uses: silicon, ferrosilicon, and silicon alloys of other metals such as copper; flux in smelting basic ores; foundry mold-wash; foundry parting-sand. The greatest deposits of silica applied to industrial uses are found in Belgium and Germany. The next greatest deposits are in the U. S. (Illinois, New Jersey, and California). Belgium not only produces and exports silica, but manufactures every known kind of glass and glassware. Germany likewise manufactures glass and its ceramic production is among the best in quality and design. American ingenuity has so developed mass glass production that today this country produces, by mechanical processes, the finest glass products in the world. F.P.H.

Systems of paying workmen. H. M. KRANER. *Ceram. Age*, **11** [5], 174–76 (1928); *Ceram. Ind.*, **10** [6], 632–34 (1928).—At the spring meeting of the A.S.M.E., May, 1928, K. described the application of standard time and several other incentive systems to an electrical porcelain plant. The necessity for detailed study of the various operations in determining the applicability of the systems is pointed out. The disadvantages of the simple piece-work system so commonly employed in porcelain plants are discussed. A flow sheet for plastic process porcelain manufacture is given. One of the objectives of the study is to make accurate cost data possible. A.E.R.W.

Economic consequences of the collaboration of employers and workers in the U. S. CH. DE FREMINVILLE. *La Ceramique*, **30** [471], 93–96 (1927).—After pointing out the importance of coöperation between labor and capital, F. gives the history of coöperation and quantity production in the U. S., laying particular stress on the scientific management developed by Taylor. The attitude and policies of the labor unions are praised. A.E.R.W.

Field of application of the systematic organization of work. CH. DE FREMINVILLE. *La Céramique*, **30** [472], 117–25 (1927).—De F. shows that the field of application of the "Taylor System" of organization of work is practically unlimited. The origin and principles of Taylor's system are described, and its mode of application illustrated by giving the results of studies of brick laying, shovelling, etc. De F. discusses the development of the spirit of coöperation, the collaboration of the labor unions, and the fight against waste. A discussion of the paper is reported. A.E.R.W.

Meeting of the Society of Manufacturers of Ceramic Products of France. ANON. *La Céramique*, **30** [472], 126–47 (1927).—A detailed account is given of the meeting of the Society held May 18, 1927. A.E.R.W.

Experimental investigations of pyrometric cones. A. GRANGER. *La Céramique*, **30** [473], 165–68 (1927).—G. gives a brief history of Seger cones and of decimal cones (French). The theory of the use of cones in ceramics is outlined and it is shown that the end point of a cone depends not only on its composition and temperature but also on the duration of heating and the dimensions of the cone. The results of a number of experiments are given in which the end points of cones of different sizes of both

German and French cones were determined by means of noble metal couples and Féry and Pyro radiation pyrometers. The work of Leduc and of Fairchild and Peters is discussed. A.E.R.W.

French ceramic exposition. ANON. *La Céramique*, **30** [473], 169–84 (1927).—An illustrated description is given of ceramic materials and a large number of machines used in the manufacture of ceramic products. A.E.R.W.

Glass and pottery industries in China. ANON. *Keram. Rund.*, **36,** 136–37 (1928).—China has large quantities of clay and cheap labor but the production of clay ware is hindered by poor organization and lack of capital. China has about 60 glass and ceramic plants of some importance. Production methods are still very crude. H.I.

Qualities of a brick wall. R. E. STRADLING. *Brit. Clayworker*, **37** [433], 79–86 (1928).—A short discussion on the development of stonework and brick from the early and middle ages down to the present day. The demands on brick walls are stated as follows: (1) weather protection, (2) suitable external appearance, (3) suitable internal appearance, (4) lasting qualities, (5) economy and cheapness in construction. Each of these demands is discussed in detail. R.A.H.

Secondary metals in 1926. J. P. DUNLOP. Bur. Mines, *Mineral Resources of the U.S.*, Part I, pp. 275–95 (1926).—Secondary metals are those recovered from scrap metal, sweepings, skimmings, and drosses. Data on recovery of secondary copper, tin, lead, zinc, aluminum, nickel, antimony, and platinum are given. R.A.H.

Sand and gravel in 1926. ESTELLE R. PHILLIPS. Bur. Mines, *Mineral Resources of the U.S.*, Part II, pp. 281–93 (1926).—The production of sand and gravel reported as sold or used by producers in the U. S. in 1926 exceeded that of any previous year and amounted to 183,100,818 T. of which 92,114,279 T. were sand and 90,986,539 T. were gravel. Sand and gravel sold or used by producers in the U. S. is given by states for 1925 and 1926, and uses are tabulated. The sands and gravels are classified as follows: glass, molding, building, paving, grinding and polishing, fire or furnace, engine, filter sands, and building, paving, and railroad ballast gravel. R.A.H.

Lead in 1926. AMY STOLL. Bur. Mines, *Mineral Resources of the U.S.*, Part I, pp. 355–70 (1926).—Refined primary lead produced in the U.S. from domestic ores in 1926 amounted to 680,685 T. against a total output of foreign and domestic ores of 798,941 T. The introduction gives a summary of important lead deposits in other countries. R.A.H.

Business of selling. STANLEY A. PHILLIPS. *Brick Clay Rec.*, **72** [11], 782–88 (1928).—A thorough discussion of the selling end of a business, taking up the old methods employed and showing the changes which have been made as a result of the advent of the business corporation and large scale production. Methods of increasing profits of a business and the factors and relationships they show, are listed. E.J.V.

Industrial research in Finland. ANON. *Chem. and Ind.*, **47,** 494 (1928).—The A. B. Centrallaboratorium has published an illustrated brochure indicating the progress made since 1916, when a group of manufacturers, scientists, and financiers decided to establish a central laboratory for industrial research. From 1916 to 1919, the technical staff worked as guests of the University at Helsingfors, thence until 1925 they were established at Åbo, and in the early part of that year they took possession of their permanent home in Helsingfors. Naturally, the investigations which have been so far undertaken are mainly concerned with the wood industry and its by-products, but one research in progress is on the acid-proof qualities of brick and boiler fittings. H.H.S.

Boiler scale and its prevention. H. WALDE. *Wiss. Veröff. Siemens-Konz.*, **6,** 151–70 (1927).—A method of presenting the results of analyses of boiler feed-waters and of boiler-scales has been elaborated in order to classify the various types of in-

crustation and bring them into relation with the feed water. Three ratios are calculated for the water, and three for the deposit, (1) the ratios of silica to lime and of magnesia to lime for both, (2) the ratio of sulphate hardness to carbonate hardness for the water, and (3) the lime as sulphate to the lime as carbonate for the deposit. The significance of these ratios is discussed, and a classification of the different types of scale and sludge suggested. The chief types of scale are the gypsum and calcium carbonate scales, and mixtures of these, and the silica type. The sludges contain oxides of iron and aluminium, generally also silica and magnesia, and often organic matter. The various methods of preventing scale are examined, and the Cumberland electrolytic method more particularly discussed and recommended. (*B. C. A.*)

PATENTS

Molders' cores. A. STAHN. Brit. 288,587, June 7, 1928. A binder for making self-supporting cores from quartz sand comprises a water-soluble agglutinant and an oil-soluble pitch mixed together. For instance, 30–70 parts of sulphite liquor of 35° Bé and 70–30 parts of stearine pitch may be used. Not more than 4 parts by weight of this binder are required for 100 parts of sand.

Treating aluminium surfaces. B. JIROTKA. Brit. 286,729, May 2, 1928. Articles of aluminium or aluminium alloys are provided with zinc coatings by treatment with solutions of zinc salts containing also an alkali borate, *e.g.*, mixtures of sodium cyanide, zinc carbonate, and borax, or of sodium bicarbonate, potassium bicarbonate, zinc carbonate, and borax. The articles may be dipped in the hot solutions, or the solutions may be painted or sprayed on the articles.

Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering COLUMBUS, OHIO

Founded 1895

Curriculum—Ceramic engineering and technology. Advanced research in cooperation with State owned plants and Federal Government.

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS

NEW YORK STATE SCHOOL OF CLAY-WORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Founded 1900

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

SEVEN INSTRUCTORS *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering URBANA, ILLINOIS

Founded 1905

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products.

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Founded 1906

Curriculum—Ceramic Engineering major, Ceramic Technology and Pottery subordinate.

THREE INSTRUCTORS *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Founded 1910

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering SEATTLE, WASHINGTON

Founded 1918

Curriculum—General ceramic engineering with research in ceramics and non-metallics.

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Founded 1921

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Founded 1923

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW — *Instructor:* GEO. J. BAIR

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT

Founded 1923

Curriculum—Ceramic Technology and Engineering

TWO INSTRUCTORS — *Director:* A. V. HENRY

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE & ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923

Curriculum—Ceramic Engineering

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WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

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Curriculum—students selection of ceramics includes chemical and engineering principles applied to ceramic manufacture.

TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827. Department of Metallurgy, Ceramic Division, 1925.

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES & METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Founded 1926

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Head of Department:* M. E. HOLMES

LOUISIANA STATE UNIVERSITY

BATON ROUGE, LA.

Ceramic Department founded 1926

Curriculum—Ceramic Engineering

Head of Department: J. W. WHITTEMORE

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Department of Fine Arts COLUMBUS, OHIO

Founded 1927

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of the
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A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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Vol. 7 August, 1928 No. 8

EDITORIAL

THIS COÖPERATIVE EFFORT

We all have ambition. Ambition is one of the essentials to success. Ambition, however, will not get us very far unless it is backed by fundamental information and judgment.

Judgment is acquired from practice but the amount and quality of judgment acquired depends on our talent for judgment. We can acquire sufficient judgment to hold our own in human activities.

Knowledge is acquired by study and practice.

If we have the ambition to acquire judgment and knowledge we should be actively coöperating with our fellow ceramists in recording proved ideas, processes, and experiences. We can originate only a fractional portion of the knowledge essential to us for efficient production and quality product. We are dependent, perhaps more than we realize, on obtaining knowledge from others.

Those who were on the ceramic tour abroad learned that we are as provincial and backward as any people. We have much to learn from ceramists in all parts of the world. The ceramists: clay, glass, and vitreous enamel, of no individual country have exclusive knowledge of how to produce the best ware. Each has perfected methods, equipment, and mixtures which for definite purposes are superior. There is no monopoly on ceramic knowledge.

Trade secrets are now held only in regard to new ware developments and these secrets are possible only until the new ware is on the market. There is no such thing as process secret. If we believe we have something unique, not known by others, we should visit other factories and become acquainted with their progress. Just such enlightenment was obtained by those who traveled through the ceramic centers of Europe. Their own knowledge and ambition was sharpened by new contacts.

As ceramists we need an organized agency through which we can pool our discoveries and developments. Your individual appreciation of this need is shown by your membership in this SOCIETY. Much more than your membership it is your participation that you need if you are to make of this agency your most effective means of obtaining that knowledge and judgment required to obtain the fulfillment of your ambitions.

OUR COMPETITORS

Substitute products have won a large market in spite of the proved superiority of clay and glass. Is it due to superior advertising and sales effort?

For centuries the clay and glassware manufacturers did not have to be so keen to create a market. The demand for their ware was steady. Yet over 200 years ago Wedgwood created a demand where before there was none. He made a superior product and made it into ware that satisfied aesthetic tastes since that time. A casual survey through the old world museums will bring us to a realization that in the years immediately past there was a decided decadence in quality of ceramic products. The terra cotta of the 15th Century would stand well in comparison with that of the present day as would most all clay, glass, and vitrified enameled ware.

Why are the superior brick surfaced pavements displaced by concrete and asphalt? Why are concrete sewer pipes making such inroads? Why do we not have more clay tile roofs?

The answer is that we ceramists have been tardily following rather than taking the lead in making products of quality required for specific purposes and we have paid but little attention to the engineering requirements which construction materials must satisfy.

A study of codes and books on engineering data will show that producers of substitute products know more than do ceramists about the value of their product for construction and engineering purposes.

The Palace of Peace at The Hague is a monument to ceramic prod-

ucts. It is the best ceramic exhibition the writer has ever seen. The interior tile decorations, the fountains, the art ware, the building itself, the surrounding walks are all 100% ceramic ware put together artistically and for a useful purpose. The tile was made to specification to decorate the walls or to sustain floor travel. Many of the European hotels have public rooms completely tiled. Most all of the buildings, homes, and barns are roofed with clay tile. Europeans have a developed taste and a practiced engineering ability for the fullest employment of ceramic ware that gives very little opportunity for competition from substitute products.

This is a plea for cultivation of a market by studying the artistic and engineering value of ceramic product for specific purposes. If this is done for such industrial products as spark plugs, electric insulators, grinding wheels, etc., why not for household and construction products?

PAPERS AND DISCUSSIONS

DRIVING CLAY-WORKING MACHINERY[1]

By Davis Brown

ABSTRACT

Illustrating and describing the application of various power transmitting and speed reducing devices with suggestions for further simplifying the methods of applying motors to machines to be driven.

Introduction

The means for driving machinery is important to every manufacturer of clay ware. As the various mechanical units multiply and become located farther from each other the distribution of power to individual machines becomes more complicated.

Consideration should, therefore, be given to reliability, economy of operation, location, and cost. Any drive which does not stand continuous service or which requires frequent attention is costly; or one which must be so located as to interfere with the flow of material by the shortest route from one place to another, which becomes dangerous to human beings or prevents access to other parts for inspection, servicing, or cleaning, should be avoided.

A new plant can easily be planned to give adequate service but it is sometimes difficult to secure when revamping an old one.

Speed Reduction

Transmission losses are unavoidably increased by the addition of necessary speed changing devices between the source of power and the working parts of machinery. The auger in a brick machine, for example, may be found running from 10 to 40 revoultions per minute while the line shaft from which the power is taken may be running from 150 to 300 revolutions per minute or if motor-driven, the motor operates at a speed of from 514 to 1200 revolutions per minute. The problem is to transmit power to the auger at the desired speed from the line shaft or the motor with the least amount of loss by friction.

The source of the friction in transmission devices is the shaft bearings, the sliding on each other of the teeth of gears used in the reduction of speed from one to the other, and friction within belts as they bend around pulleys and straighten out again.

It is obvious that changes in speed should be accomplished with the fewest possible number of parts consistent with proper design, meaning that shafting should be of ample size and supported at

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Heavy Clay Products Division.) Received November 25, 1927.

proper intervals to avoid excessive deflection; gearing should be of correct proportions, accurately made from as hard a material as consistent with strength and workability; the bearings should be as nearly frictionless as possible, the belting not too thick, and the pulleys of ample diameter; all are consistent with a high safety factor and tending to lower the transmission losses and should be considered as a whole.

Speed Variation

There are certain machines used in the manufacture of clay ware that function well at known speeds. There are other machines whose speed cannot readily be predetermined and require flexibility in changing of speeds, with considerable latitude in providing a sufficient amount of power; *e.g.*, for all machinery used for grinding and transporting material the speeds are well standardized. The auger machine and pug mill are the main exceptions. Generally, the proper basis for determining the size of auger machine is the cross-section dimension of the ware to be made, while quantity determines the proper speed to drive the auger. Another variable factor is the clay itself; some clays require that the auger be driven at a faster speed in order to obtain the same production.

Manufacturers of clay-working machinery, for example, find that one particular size of machine is making as low as 3000 brick per hour in one plant while a duplicate of that machine is making 10,000 brick per hour in another plant, accomplished by driving the auger at different speeds.

It is to meet the various requirements as to quantity of output and the varying character of the materials that so wide a variation in speed of the auger or screw is imperative.

The foregoing statements have a bearing on the selection of a suitable means for driving the machinery.

Selection of Drive

There are, in reality, but three kinds of drives or three different ways for driving machinery: (1) by grouping all machines so as to be driven from a common line shaft, (2) by individual motor drives for each machine, or (3) by some combination of the two methods.

The following description of the various methods in use in a typical small brick plant has been selected for the purpose of illustrating these drives.

Belt Driven Plant

In this type: shown in Fig. 1, the power may be furnished by a steam engine and boiler, gas, or oil engine, electric motor, or water power.

The grinding is done in two stages. The crusher is fed by a reciprocating feeder, discharged to an elevator, is elevated to a bin, delivered to the grinder by means of a reciprocating feeder, and elevated to a storage bin from which it is delivered to the combined machine by means of a spiral feeder or a disk feeder.

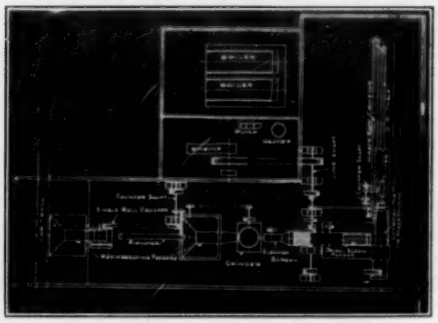


FIG. 1.—Plan view.

The line shaft is driven by means of a belt and in turn drives the grinder, combined machine, spiral feeder, elevator, screen, (if belt driven) the counter shaft, the waste-clay conveyer, and the automatic cutter. The counter shaft drives the reciprocating feeder, crusher, and elevator, while the second reciprocating feeder is driven from the grinder. It is permissible to drive the reciprocating feeder which supplies the single-roll crusher from the crusher shaft and the reciprocating feeder which supplies the grinder from drive shaft of grinder, but it is necessary to have provisions for stopping each feeder without stopping the machine which it supplies with material; all other machines should be driven from the line shaft or the counter shaft.

The drive for this installation requires five line shaft bearings, two bearings for the counter shaft, and ten belts. There is a small counter shaft for driving the automatic cutter which may also be used to drive a waste clay elevator, conveyer, and suitable feeder.

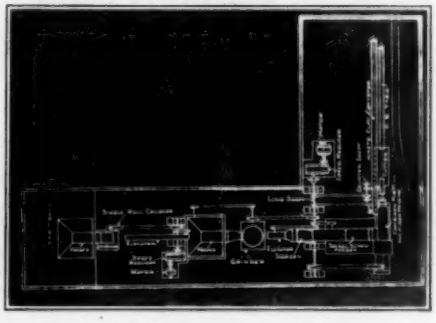


FIG. 2.—Plan view.

The cutter is frequently driven from the auger machine by means of a shaft near the floor line and passing the machine. Why this dangerous obstruction is tolerated is hard to say, yet it is common practice. A better and safer drive for this piece of machinery is from an overhead counter shaft or from a shaft located below the floor line and properly covered.

The same plant may have the machinery divided into two groups. (See Figs. 2 and 3.)

The line shafts are driven by means of motors through speed reducers; belts may be substituted for speed reducers and the line shaft may be driven from the center or either end; with this drive there are eight belts, four main line shaft bearings, and two small line shaft bearings.

An individual motor drive for each machine and all driven through various speed reducing devices is another variation. (See Fig. 4.)

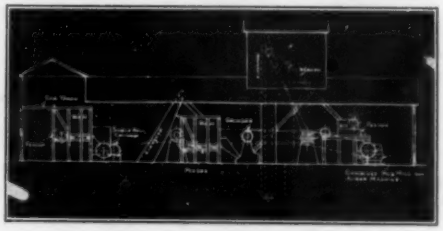


FIG. 3.—End elevation.

For the crusher a belt of some sort can be used, or if a geared speed reducer is used a flexible coupling having springs for cushioning the shocks and preventing them from reaching the gearing or the motor is desirable.

The reciprocating feeders are driven through a geared speed reducer, the elevators through the worm gear drive; the grinder is driven direct, having been designed for that purpose. In this case, a slip ring or a high resistance type motor is necessary unless a friction cut-off coupling is used between the motor and the grinder.

The spiral screw feeder is driven by means of a worm gear drive and the combined pug mill and auger machine through a speed reducer and friction cut-off coupling. The cutter is motor driven through a gear reducer and the waste clay conveyer by means of a worm gear drive.

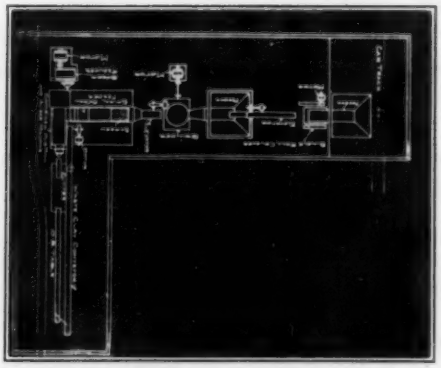


FIG. 4.—Plan view.

In choosing a motor the starting load must be given consideration and a motor must be selected that will either start the machine from rest when fully loaded or can be connected to the machine through a friction cut-off coupling.

The advantages of belts for driving machinery over direct connection are: (1) they slide when the machinery is greatly overloaded; (2) they permit greater flexibility when it becomes necessary to alter the speed of the machine which it drives; (3) friction losses within the belt itself (provided its thickness is not too great, the width is sufficient for the load, and pulleys are of sufficient diameter) are be-

believed to be very low, varying greatly with different kinds of belts; the more flexible the belt the lower the loss.

The disadvantages are that they require much valuable room and when stressed beyond their normal capacity require frequent attention.

FIG. 5.—Short belt drive with weighted idler.

Crossed belts are frequently a necessary evil but with the proper distance between shaft centers and the belt not overloaded, the disadvantages are not serious.

Wherever possible the drive should be so planned as to have the slack side of the belt the top side.

There are some forms of short-belt drives; one of which has a weighted idler to supply the necessary tension within the belt, shown in Fig. 5. These short-belt drives permit a higher reduction in speed ratios by increasing the arc of contact on the smaller pulley and tension is automatically held uniform. This drive requires a belt that is quite flexible, like leather or rubber; it is known as the "Lenix" drive and will work with either a horizontal or vertical belt.

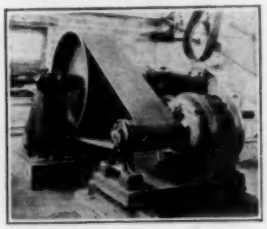


FIG. 6.—"Texrope" short belt drive.

Another short-belt drive, known as "Texrope" (Fig. 6) consists of two grooved pulleys with an endless belt for each groove. The belt is triangular in shape with the contact on the sides of the grooves. From observations made of this drive in actual use, it seems to be giving highly satisfactory service.

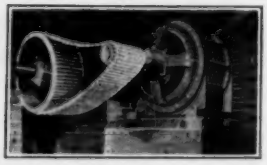


FIG. 7.—Silent chain drive.

The silent chain drive (Fig. 7), one of the oldest drives, is well known, has given good service, and for maximum durability should be run in an oil tight, dust-proof ase.

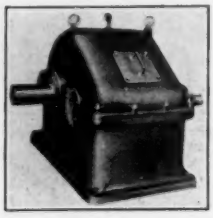


FIG. 8.—Gear reducer.

Gear reducers fit in nicely for many direct connected drives (Fig. 8). They do not increase the width dimension which is generally the most valuable and when herringbone or helical type gears and roller bearings are used, friction losses are low and they are practically vibrationless.

For comparatively high ratios of speed reduction the worm gear (Fig. 9) is coming into greater use for units up to 100 H.P. Details of construction have been improved from time to time so that it may be relied upon when the proper selection has been made and the right kind of lubrication provided.

FIG. 9.—Worm gear.

Any one of these drives may safely be resorted to for obtaining the necessary speed reduction and for transmitting power, provided the load and speed can be predetermined and a liberal safety factor adhered to.

The number of machines that are being driven direct from a motor is increasing. Manufacturers of clay-working machinery are progressive; therefore further simplification in the application of the motor to the machine to be driven can be expected. In fact, a beginning has already been made.

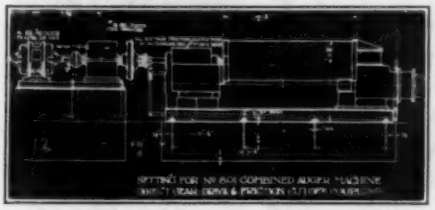


FIG. 10.

Figure 10 is a combined machine driven by a motor through a gear reducer and a friction cut-off coupling while Fig. 11 is a similar machine driven through a pair of gears. The gear is mounted on the machine shaft and the pinion on the motor shaft; the latter is a simple and direct method with few parts and is offered for consideration.

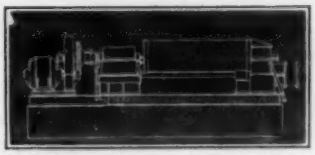


FIG. 11.

Figure 12 is a grinder driven by means of a direct connected motor. The motor is on a separate foundation and there is a short piece of shafting and two flexible couplings between the grinder and the motor, which works admirably. The necessity of the short shaft and extra coupling is undetermined.

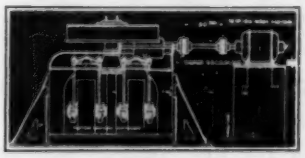


FIG. 12.—Grinder driven by means of direct connected motor.

In Fig. 13 a pan with direct connected motor is shown mounted on the cross-frame. With care in installing the motor so as to obtain correct alignment and proper mesh of gears, this works out very well.

A motor-driven drum or hoist is shown in Fig. 14 because where this device is used for bringing in raw materials it is generally located

in a remote part of the plant and the motor furnishes an ideal form of drive.

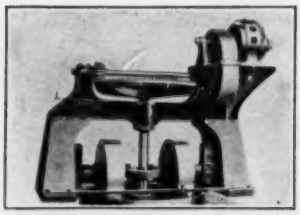


FIG. 13.— Pan with direct connected motor mounted on cross frame.

In selecting individual motor drives both the manufacturer of the machinery to be driven and a competent electrical engineer should be freely consulted as there are certain points to be considered that if taken care of properly at the start will result in efficient operation. The most difficult item is to predetermine the correct-sized motor to use for each machine; in fact, the variables are such that provision should always be made for power factor correction by installing a synchronous motor for one of the drives. The auger machine is a very good place to use this type of motor.

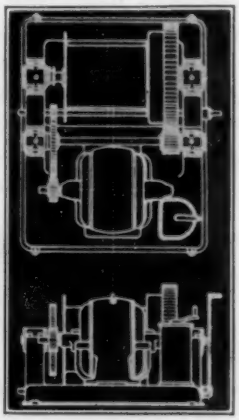


FIG. 14.—Motor-driven drum or hoist.

In transmitting power to machinery it is advisable to do so in the most direct and simple method with the fewest number of parts consistent with obtaining desired results. Therefore, as previously stated, further simplification from time to time is certain.

W. A. RIDDELL CO.
BUCYRUS, OHIO

FUEL MIXING WITH CLAY[1]

BY R. C. GANGWERE

ABSTRACT

The question of fuel cost reduction is very pertinent. Mixing cinders with clay produced a granular structure which stimulated drying and reduced firing expense. Other methods tried are mentioned.

At every manufacturing plant the pertinent question of how the fuel cost can be reduced is raised. Local conditions must always be well considered before making any changes; for instance, the Scott system is used at one of our plants, setting the brick fourteen high direct from the machine. There are not many clays that will stand up under such superimposed weight. Another instance is seen in the case of stiff-mud

[1] Presented at the Annual Meeting, AMERICAN CERAMIC SOCIETY, Atlantic City, N. J., February, 1928. (Heavy Clay Products Division.) Received December 13, 1927.

brick, made of very close grain plastic clay which will take more fuel to fire than soft-mud brick made of a pervious clay.

A number of years ago it was noticed that fine coal was poured between the brick and wall at each corner, when the firing of the kiln was nearly completed. This worked well, but produced a local result, not affecting every brick in the kiln. So for several years this matter has been given considerable study.

Mixing Cinders with Clay

At one plant in Alabama, after years of experimenting with screening cinders and coal mixed in the clay, it was decided to put a dry pan in for this purpose.

By using all of the available cinders from boilers and kilns, it was found that the capacity of the plant was increased and the firing expense was considerably reduced. It also developed that the drying was stimulated, due to the fact that the clay-cinder mixture was of a granular nature.

This granular structure of the cinders and coal prevented the bloating of the brick, because it facilitated the escaping of steam or moisture from the center of the brick. It also eliminated cracking in drying and the waste and shrinkage was reduced to a minimum.

Experiments have been made at another plant, mixing four, six, eight, and ten ounces per brick in a kiln of 350,000. The result was a shortening of the firing time and also giving the product a darker shade.

At the same plant six "eyes" of one kiln were set with brick of mixtures of the fuel, while the remainder was without it. It developed (this clay takes from 16 to 18 days to fire) that in the first four days the heat was reaching toward the top more rapidly than at any other place in the kiln. In addition, settling of the brick occurred a few days ahead of the rest of the kiln.

By weighing the brick with and without mixture, it was found that the amount of fuel mixed per unit reduced the weight nearly equal to the weight of fuel mixed into the brick.

If the freight rate is 7 cents per hundred and the weight is reduced 6 ounces or 375 pounds to a thousand, there will be a saving in freight of $26^1/_4$ cents, or on a ten-ounce mixture, $43^3/_4$ cents.

The length of firing time is reduced, and the brick will not shrink in proportion to the weight it loses. This gives two advantages that all brick men are interested in: less weight without reduced size.

It is said that a company in England mixed coal dust with clay, and after getting the mixture hot enough to ignite, closed up the kiln until the carbon was burned out. The mixing of coal dust is generally practiced in the Hudson River yards and in the Chicago district.

If this matter is given the attention it really deserves and its technical points were fully worked out with the carbonaceous clays, the black shales of Ohio, and the black cretaceous clays of New Jersey, a large saving would result. These clays are difficult to fire because of their carbon content. The carbon in such clays after igniting burns at such a rate as to produce black coring or fusion.

Proper Fuel to Use

The fuel and clinker to be used in a given instance must be given the same consideration technically as is given to the kind of clay required. Anthracite or coke would be best for many clays because they are low in volatile matter and consequently do not cause bloating. Bituminous coal is not only highly gaseous but it burns rapidly and develops a high temperature resulting in fusion of the particles coming in contact with each granule of coal. The result may be bloating.

Not all brick manufacturers are located in the anthracite region and for these a mixture of bituminous screenings and cinders will prove to be economical. The ashes will contain at least 10% and in some cases 20% of combustible matter. The fuel in the cinders is all coke minus the gas and if properly mixed and not too fine, good results will be obtained.

Proper mixing is also very important. The proper amount of coal and cinders should be dropped into each car of clay. Putting the coal and cinders into the pug mill would not give uniform mixing.

Chattanooga River Brick Co.,
Chattanooga, Tenn.

THE VARIETY OF CLAYS OF WASHINGTON AND THEIR ADAPTABILITY TO CERAMIC INDUSTRY[1]

By Edward Burkhalter

ABSTRACT

A brief description of clays in the Northwest which have a proven industrial value.

Clays of Recent Formation

From a geological standpoint it is well understood that the various mountain ranges of our western coast are comparatively recent in formation. In the formation of clays a number of agents have shown their work and it may be that this section has been especially benefited by electro-chemical action. Large clay deposits are found giving evidence of the action of water in transporting and depositing material,

[1] Presented at the Annual Meeting, American Ceramic Society, Atlantic City, N. J., February, 1928. (Heavy Clay Products Division.) Received December 15, 1927.

while on the other hand many deposits are clearly weathered in place. Glaciation and wind action have also played a part and in some instances there is evidence of a mixture of geological agents which have been at work to bring about desired chemical and physical changes. Eastern Washington is rich in plastic clays which are lacking in western Washington where heat and pressure of crustial movements have brought about the formation of shales.

Clays near Spokane The city of Spokane lies on the western slope of the Rocky mountains in what is known as the Okanogan Highlands. Large masses of granite to the north and crystalline rock to the east have contributed bountifully to the clay deposits of this center.

Description by Districts

Spokane At present there are but two large clay companies in this locality, The Washington Brick, Lime, and Sewer Pipe Co., and The American Fire Brick Co., making products from local clays which include fire brick, face brick, terra cotta, hollow building tile, sewer pipe, wall tile, floor tile, and some art ware. The clays of the locality are not limited to these products for they are suitable for the production of all heavy clay products and art ware, including white ware made of local washed kaolin.

East of Spokane Southeast of Spokane a residual white-firing clay is found in large quantities which as yet has not been well developed. The deposits are used for the production of high grade refractories at present but from tests conducted at the University of Washington it has proven to be adaptable to the manufacture of white ware. While the percentage of pure kaolin is low for the deposit as worked there are strata which run nearly pure with the exception of a small amount of iron stain which is always present. A remarkable feature of this kaolin is its plasticity which would eliminate the use of ball clay for whiteware bodies. These deposits are worked in open pits usually situated on a slope, for the country is generally hilly.

A granite clay which has been weathered *in situ* and contains lumps of granite in the last stages of decomposition is being worked from open pits. The sandy overburden of this deposit is being used in a mixture with a plastic buff-firing clay for the production of sewer pipe. The granite clay is being used for the manufacture of refractories with a percentage of plastic clay to form a neutral brick of rather low porosity. Other deposits in this same locality have been transported a short distance and have been improved by this action for use in firebrick manufacture.

One of the most interesting and largest deposits now being worked in

the Spokane region furnishes clay for the manufacture of architectural terra cotta, art and floor tile, and a high class pottery. The deposit having two or three feet of overburden is worked from an open pit by hand, using a narrow gage dump cart to the bunker from which the clay is hauled by truck to the railroad. The working face of 12 to 15 feet is of a clear light buff-firing clay which is being used alone with the addition of 50% grog in the manufacture of architectural terra cotta. This deposit is accompanied by and resting on a stratum of red clay of similar physical properties which is being successfully used as a body colorant. Strong buffs to deep reds are obtained by the use of this clay in amounts up to 25%. Similar deposits of red clay are to be found throughout the Spokane district and have been used by the natives as a color in painting barns. Also from this pit a fine plastic stoneware clay is found which at the present time is used for casting a small amount of art ware. The plastic qualities along with fine drying qualities mark this as an unusual pottery clay which gives no trouble with deformation up to cones 5 to 6. The various clays from this pit run very uniformly through the deposit and have eliminated many manufacturing problems by their purity.

North of Spokane North of Spokane is found another pit interesting for its variety of clays. Here may be found white, red, black, and blue clays, and quantities of sand suitable for use in the manufacture of brick. Because of the variety of raw materials found in this pit a large variation in color work for face brick is made possible in the work of the brick plant located on the site. At present this pit is being worked by the use of specially equipped Fordson tractors which are able to work the soft clay banks with very little blasting, the tractors being used to dig from the bank and load the dump car or wagon which operates from the bank to the clay shed. The pit is favored with a light overburden and although a great deal of the material seems to have been laid down in pockets there is no end to the amount of raw material to be worked. It is interesting to note that the clay deposit is accompanied by a basaltic rock flow which has driven off part of the chemical water of composition. This rock flow is well defined throughout the area and varies in thickness from a fraction of an inch to three and four inches. A slight loss in plasticity is noted in these clays, otherwise the physical properties have not been changed by the basaltic formation.

Further north and at a slightly higher elevation another clay field is found with no evidence of the rock flow. This clay is worked in a small way from open pits and at present is being used for pottery and the production of art tile. The deposit seems to be extensive as similar samples are found in well drillings over a large area. For a clear buff-

firing clay of fine working properties suitable for the production of art ware and terra cotta this deposit is to be highly recommended.

It is interesting to note that little difficulty has been experienced in winning the clays in this section as all are worked from open pits where little overburden is encountered. Many excellent deposits remain unworked because of their inaccessibility to roads and railroads and the present limited demand for raw material.

In no instance is clay found in conjunction with coal in the Spokane area. The manufacturing problem of clay preparation is a simple one as in every case the material may be easily slaked in water. No finer clays for workability, for drying and firing properties, and for such a multitude of uses can be found in any section of the country as those of the Okanogan Highland.

Southeastern Washington

Southeastern Washington contains one of the largest basaltic rock formations of the country and here may be found many fine basaltic red-firing clays which as yet have seen very little development. Various clay deposits have been located in sections of the Cascade Mountains of the state but have been little developed.

Considerable quantities of diatomaceous earth are being mined in the state to be used mostly in the ground state as little of the material is suitable for cutting into brick form.

Aside from the shales of western Washington certain glacial clays are being used mostly in the manufacture of face brick as their short firing range prohibits their use in the manufacture of vitrified products.

Much useful data concerning the location, formation, and uses of the clays of Washington may be found in the University of Washington Engineering Experiment Station, *Bull.*, No. 18, "The Clays and Shales of Washington: Their Technology and Uses", by Hewitt Wilson.

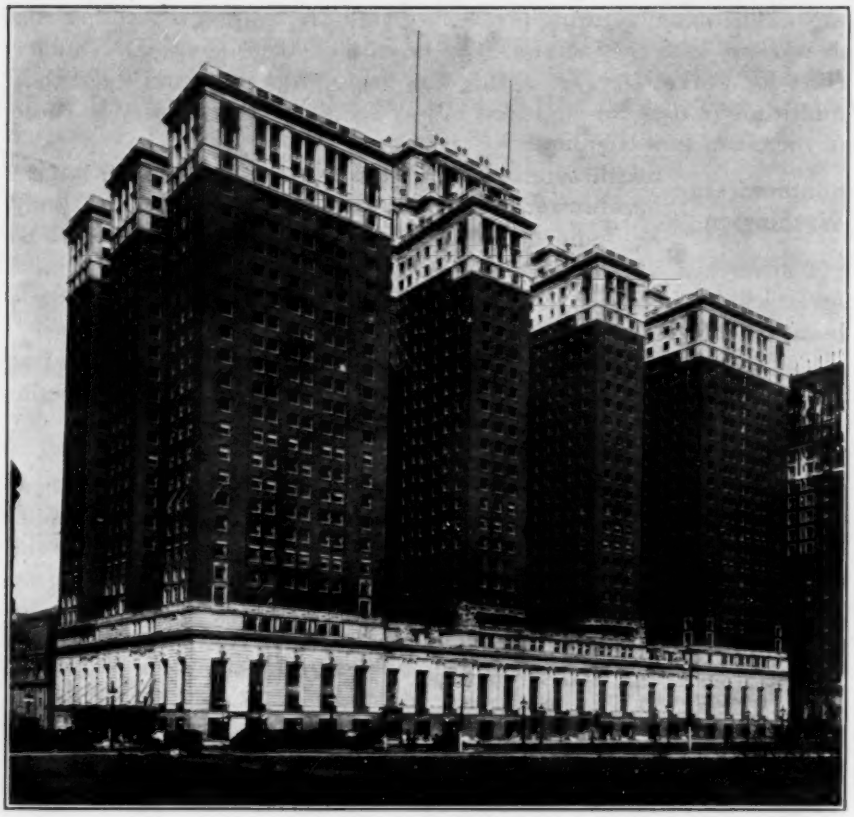
WASHINGTON BRICK, LIME, AND SEWER PIPE COMPANY
SPOKANE, WASHINGTON

ACTIVITIES OF THE SOCIETY

THE 1929 ANNUAL MEETING

Announcement is made that plans have been completed for a national celebration of American Ceramic Week, in connection with the thirty-first annual meeting of the AMERICAN CERAMIC SOCIETY at the new Stevens Hotel, Chicago, February 4 to 9, 1929.

Plans have been formed to make this convention more unique and interesting than others held in the past. A feature of the 1929 Convention will be the American Ceramic Exposition which is headed by D. F. Albery of the Northwestern Terra Cotta Company as Chairman. There will be an elaborate showing of ceramic ware,



STEVENS HOTEL

including colored enamel ware, tiled rooms, stoves, refrigerators, sanitary ware, table glassware, vita glass, etc. In addition there will be a complete exhibit of machinery, equipment, and raw materials. To take care of these exhibits, every inch of space in the large exhibition hall of the Hotel Stevens, will be devoted to the project.

All trade associations in the ceramic field have been requested to plan their meetings to coincide with that of the AMERICAN CERAMIC SOCIETY and participate in the convention. A number have already agreed to do this. Special invitations will be sent to buyers of ceramic products throughout the United States.

Requests have been received to throw the exposition open part of each day to those in the great central market who are interested in viewing the elaborate showing of ceramic ware.

Leading department stores and ceramic shops will devote a large part of their window space to the display of ceramic products during American Ceramic Week.

With Mr. Albery as general chairman are some thirty members of the Chicago Section who make up the executive committee in charge of arrangements. Headquarters for the convention and exhibition have been opened at Room 415, 37 West Van Buren Street, Chicago, Illinois.

The officers of the AMERICAN CERAMIC SOCIETY are MacDonald C. Booze, Charles Taylor Sons Co., Cincinnati, Ohio, President; R. R. Danielson, Metal and Thermit Co., New York, Vice President; H. B. Henderson, Standard Pyrometric Cone Co., Columbus, Ohio, Treasurer; R. C. Purdy, 2525 N. High Street, Columbus, Ohio, Secretary.

THE CERAMIC TOURISTS' RETURN[1]

A party of sixty-eight ceramists boarded the S. S. Tuscania on May 18 for a six weeks tour of Europe. Expectant as they were of new experiences and broadened knowledge no one of this tour anticipated the extensiveness of the opportunities which the ceramists abroad had planned. Frequently as they progressed on the tour its members would give testimony that they had already had their money's worth.

FIG. 1.—Left to right: Ross C. Purdy, General Secretary AMERICAN CERAMIC SOCIETY, H. J. C. Johnston, Chairman British Committee and Past President Ceramic Society of England, M. C. Booze, President, AMERICAN CERAMIC SOCIETY, Henry J. Johnson, President British Pottery Manufacturers Federation, J. W. Mellor, Director North Staffordshire Technical School and Hon. Secretary Ceramic Society of England, Bernard Moore, England's foremost potter and Past President Ceramic Society of England.

Several members of the party who had previously traveled in Europe studying ceramic manufacturing keenly felt that on this tour they were seeing much more in less time, at considerably less cost, and with more comfort. They reiterated their statements of delight and satisfaction in lobby chats, at receptions, and where else they could testify.

To all who participated, this tour of American ceramists abroad was profitable and highly enjoyable.

[1] For additional notes on the tour see this Bulletin, p. 252.

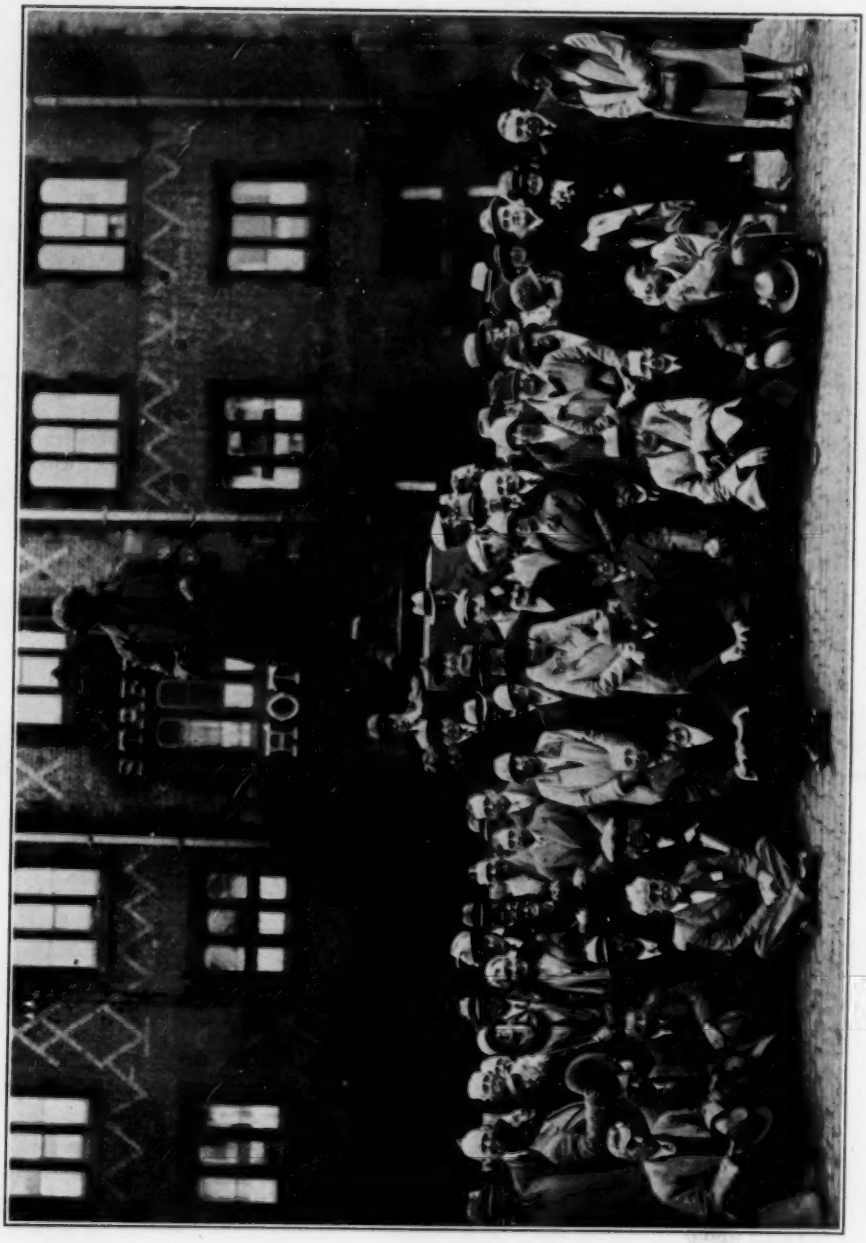


FIG. 2.—Before the statue of Josiah Wedgwood, Stoke-on-Trent (June 27).

The tour manager was skeptical about the members of the party maintaining to the end their intense interest in plant visits that called for rising at 6:30, breakfasting at 7 A.M. day after day, and returning to the hotel late in the day. This schedule was maintained and more was wanted by the majority. Rest days were provided and by some begrudgingly accepted. Opportunities were at all times offered for leisure and sightseeing. The individuals could go when and where they wished and several did just that. While the main party proceeded on a routine schedule there were at all times from ten to twenty of the party off on optional plant trips.

The following is a diary account of the tour as compiled from members' notes by George Simcoe, Amos Potts, Ralph Smith, Wm. Jackson, and Frank Hodek.

ITINERARY[1]

May 28 Landed at Havre 6:45 A.M.
Arrived at Paris, Commodore Hotel, 11 A.M.
Pentecost Monday. Sightseeing.

May 29 Welcome by Chamber of Commerce and Ceramic Society of Paris, 10:30 A.M.
Plant Visits—A. La Croix (colors).
Fours Rousseau Company (crucibles and refractories) Argenteuil.
Meeting of Syndicat des Fabricants de Produits Ceramiques. Papers read by A. Silverman and T. S. Curtis of the American Party.
Reception by Chamber of Commerce, 5 P.M.
Garden party.

May 30 Left for Beauvais by bus, 8:30 A.M. Manufacture Nationale de Tapisseries de Beauvais 1664. Handmade tapestries. 1 P.M., lunch, Grand Hotel de France et d'Angleterre. St. Peter's Cathedral (13th Century).
Studio of Auguste Delaherche (ceramic artist).
Tuileries de Beauvais Tile (two plants). (Mr. Duffoy managing delegate).
(*a*) Usine d'Ons-en-Bray.
(*b*) Usine d'Auneuil (entire plant reinforced concrete).
(*W*) arrived Limoges early morning. Hotel Central.
Reception—Union des Fabricants de Porcelaine.
Plant visits—Société Porcelainiere de Limoges. Haviland & Co.
Lunch—Union des Fabricants de Porcelaine.
Visits—Two museums, a cathedral, two machinery plants.
Dinner—Hotel des Charantes, Aix-sur-Vienne.

May 31 Via autobus.
Visited Sèvres Manufacture Nationale.
Visited Sèvres Museum.
Lunch at Versailles.
Visited the large and small Trianon and the Palace of Versailles. Return to Hotel.
Banquet at Hotel Palais d'Orsay by Ceramic Manufacturers of France.

June 1 Visited Campiegne—Plate Glass Works at Thurotte. (*E*) visited enamel sign plant of Edmond Jean, Paris.

June 2 Visited show rooms of Lalique and Sabino. Shopping.

June 3 (*G*) left Paris 8:30 A.M. Arrived Nancy 1:35 P.M. Grand Hotel Thiers. Sightseeing.
Left Paris 8:45 A.M. Customs and dinner about 6 P.M. Basle.
Arrived Lucerne 9 P.M. Hotel du Lac.

June 4 (*G*) visited Crystallerie de Nancy. Art Glass.
Left Nancy 11 A.M. by bus. Strassburg 7:15 P.M. Hotel de la Maison Rouge.
Sightseeing and Shopping.

June 5 (*G*) left Strassbourg 8:50 A.M. Arrived Munich 6:10 P.M. Bayerische Hoff.
Climbed the Rigi. (Boat ride.)

June 6 Left 8:35 A.M. Arrived at Zurich 9:40.
Left Zurich 1:17 P.M. Arrived Munich 9:19 P.M.

June 7 Corpus Christi Day. (Large pageant.)
Visited Bryerisches Museum and Deutsches Museum.

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[1] (*E*) Enamel (*H*) Heavy Clay (*R*) Refractories (*G*) Glass (*W*) Whitewares

(*H*) and (*R*) visited Aktein Ziglerei in the afternoon. (Bayerischerhof Hotel.)

June 8 Left Munich 7:20 A.M. Lunch at Marktredwitz. Arrived Cheb 3 P.M. Party separated.
(*H*) and (*R*) left Cheb 3:30 P.M. Arrived Prague 7:30.
(*W*) and (*G*) arrived Karlsbad, Imperial Hotel, 4 P.M. Tea at Freundschaftshof, near tower, 6 P.M. Dinner with Czechs and city officials, 9 P.M.
Moser Ludwig Glass Works.

June 9 Visited Ceramic School, glass works, porcelain factory. Left 4:40 P.M. for Prague.
Arrived Prague. Official reception at station.
Grand Hotel, Sroubek. Night autobus trip to old Beergarden. Later to Cabaret.
(*H*) and (*R*) left for Hodonin 7 A.M. Arrived 3 P.M.
Visited Slovakian Brick Co. Ltd.
Visited Art Museum.
Dinner in Hotel. Left Hodonin 7:25 P.M.
Arrived Brno 10:33 P.M.

June 10 Placed wreath on grave of Unknown Soldier. (Prague)
Reception by city officials. Picture. Sightseeing.
Castle on the Hill.
Convent Hyrcaudy.
Reception by Minister of Commerce, 6 P.M. U. S. Minister Einstein was present.
Banquet 9 P.M.
(*H*) and (*R*) visited State Institute for Silicate Industry and the Exhibition of Czechoslovak Cultural Work of the Present Day.
Left for Prague 10:45. Arrived 2:30. Joined above group at 6 P.M.

June 11 Sightseeing in Prague; A.M., visit to Konopiste Castle; P.M., visit to Karlstein Castle; President's summer home.

June 12 Left Prague 9:35 A.M. Arrived Dresden 1:45 P.M. Hotel Europahof Industrial exhibit. Dancing and refreshments in the evening with the German Ceramic Society.

June 13 Boat trip on the Elbe to Meissen. Visited Porcelain Works. Uphill to Albrechtsburg and Cathedral. Speeches and papers. "Coffee" in Castle. Back to Dresden.
(*W*), (*H*), and (*R*) left at 8:11 P.M. for Breslau Hotel Nord.

June 14 Sightseeing in Dresden by (*E*), (*G*) and others.
(*W*) left Breslau 7:11 A.M. Arrived Altwasser 8:20 A.M.
Visited tunnel-kiln plant, C. Tielsch & Co. Lunch with Mr. Heutschel. Left Altwasser 1:45 P.M. Arrived Berlin, Hotel Central, 9 P.M.
(*H*) and (*R*) left Breslau at 10:27 for Münsterberg. Visited the German Clay and Stonewares Companies' Plant. Lunch and tea at Director's home. Arrived at Berlin 11 P.M.
(*G*) visited Glasfabrick, Aktiengesellshaft, Brockwitz. Pressed and decorated glass.
Kauffman Tile plant.

June 15 Visited Steingutfabrik, Velten—Vordamm.
Tea at the home of Dr. and Mrs. Harkort.
(*R*) and (*G*) visited Dr. Endell's Laboratory. Entertainment at Dr. Endell's home.

June 16 (*H*), (*R*), and (*W*) visited Staatliche Porzellan-Manufaktur (porcelain factory). Refreshments at the home of Direktor and Mrs. Moufang. Visited the Chemical Technical School near the porcelain factory. (Seger's original laboratory). Visited airplane field.
(*G*) 9 A.M. went to Osram Maschinenglas Werk. Siemensstaat. Continuous glass melting tank for three machines, making electric light bulbs. Siemens–Schuckert Electro-Filter. Lunch at plant. 2 P.M. Sightseeing around Berlin.

June 17 Trip to Potsdam by boat. Visited the Palace. Saw Sans Souci.

June 18 Visited Kaiser Wilhelm Institut fur Silikatforschung and the Chemical Laboratory for Clay Industry. (Tonindustrie Zeitung).
(*R*) left 10 A.M. for Düsseldorf. Arrived 6:30 P.M. at Hotel Briedenbacher-Hof.

Second party to Dr. Harkort's plant and home.

June 19 Left Berlin for the Hague. Bus to Scheveningen Hotel Grand. Arrived 11:35 P.M. Met by Committee of Dutch Ceramic Society.

(*G*) and (*R*) visited H. Koppers Co., Silica-Brick Works. Visited Herzogenrath Glaswerke Bicheroux & Cie.

Lunch at the home of Dip. Eng. L. von Reis.

Visited plant of Scheidhauer & Giessing at Duysburg; joined rest of the party en route.

June 20 Scheveningen to The Hague; sightseeing; Houses of Parliament, Binnenhof, State Museum (Royal Picture Gallery). Queen's Palace (The House in the Woods) and Queen's Town Palace. Lunch at Hotel Kurhaus. 1:30 P.M. Peace Palace. 3:00 P.M. reception and lunch at the Manufacturers' Club House on the beach esplanade. 7 P.M. informal dinner at Hotel Kurhaus. 9:30 P.M. special train from Scheveningen for Hook of Holland. Off for England 11:35 P.M. on the S. S. "St. George."

June 21 Arrived London *via* Harwich 9:40 A.M. Hotel Cecil. Reception 10:30. Left 11:30 by special train to visit Pillinge Brick Works (London Brick Co.). Dinner en route all complimentary.

(*G*) 12:29 P.M. Charing Cross for Charlton, United Glass Bottle Co., Ltd.

Lunch at plant before inspection.

June 22 (*G*) visited James Powell & Sons, Harrow (lunch). Visited G. E. Glass Works and Laboratories at Wembley. Dinner at G. E. Co.

FIG. 3—After the reception in Town Hall, Prague. (June 10.)

Rockware Glass Syndicate and British Hartford-Fairmont Syndicate Ltd., at Greenford (tea).
(*H*) M. C. Booze, G. H. Brown, E. Rodgers, Jr., W. H. Crume, G. Denison and A. Potts attended first meeting of Building Materials Section of The Ceramic Society.
Heavy Clay Section left at noon for Sittingbourne.
Visited Brick Plant and Chalk Pit of Smeed Dean Company, Sittingbourne.
Banquet by English Ceramic Societies, Hotel Cecil, 7:30 P.M.

June 23 All day trip to Windsor Castle and Hampton Court. Afternoon sightseeing —Tower of London.
(*W*) left 9:30 P.M. for Cornwall.

June 24 Via train to Leamington; bus to Warwick for lunch. Trip through Kenilworth and Stratford-on-Avon to Birmingham 6 P.M., Queens' Hotel.
(*W*) arrived Newquay about 9 A.M. Hotel Victoria. Bus trip—Falmouth (lunch), Penzance (tea).
Complimentary dinner.

June 25 Lunch 1 P.M. with Chamber of Commerce, Birmingham. Visit to George Skey Co., of Tamworth. Birmingham Museum.
Chocolate Works employing 2000.
Hawson Taylor, Ruskin Pottery, West Smethwick.
(*E*) visited enamel plants of Done, Cleve and Burden, Beech and Chambers and Patent Enamel Co.
(*W*) visited Clay Mines. Left St. Austell (private car) 2:30 P.M. Arrived Birmingham, Queen's Hotel 11 P.M. Banquet.

June 26 (*W*) left Birmingham *via* bus for Worcester. Visited Porcelain Works (electric tunnel kiln). (Lunch) Stoke, North Stafford Hotel.
(*H*), (*R*), (*E*), and (*G*) left Birmingham at 9:00 A.M.
(*H*) and (*R*) visited 3 plants of H. J. & J. Pearson Co., in Stourbridge.
(*E*) visited enamel plants of Eveson & Co., and John Stevens Co.
(*H*), (*R*), (*E*), and (*G*) lunch at Talbot Hotel, Stourbridge, on to Stoke. Arrived 5:30 P.M. North Stafford Hotel.
Thos. Webb & Corbett Ltd., Glass Works at Wordsley. Lunch at plant.
Stevens and Williams, Ltd. Glassworks at Brierley Hill, Staffordshire.

June 27 Stoke-on-Trent. Welcome by Deputy Mayor at Wedgwood Monument (photograph).
Visited Dr. Mellor's Laboratory and Wedgwood's factory. Lunch at Town Hall. Laboratory of Bernard Moore.
(*W*) visited Maddock's semiporcelain factory.
Copelands, Spode.
(*R*) and (*H*) visited Trent Vale Brick Co., and Berry Hill Collieries.
Banquet by British Pottery Manufacturers' Association at Town Hall.

June 28 (*G*) left Stoke-on-Trent 9:50 A.M. *via* Derby for Sheffield 12:18 P.M. Royal Victoria Hotel. Met by Dr. Turner.
Lunch at King's Head Hotel as guests of the British Society of Glass Technology.
3 P.M. visited the department of Glass Technology, Sheffield University, Dr. W. E. S. Turner, Director, (lunch).
(*R*) and others left 11 A.M. by autobus; luncheon at the Palace Hotel, Buxton (given by the Derbyshire Silica Brick Co.); the men visited this factory. The ladies were entertained at the home of Mr. Job Holland.
Arrived Sheffield 6:45 P.M.
(*W*) a third group visited A. Meakin's Semi-Porcelain factory and left Stoke at 2:13 P.M. for Sheffield.
Banquet 7:30 P.M., at Royal Victoria Hotel, given by the Society of Glass Technology and the Refractories Association of Great Britain.

June 29 (*W*) visited Pearson's Pottery, Chesterfield (Dressler Tunnel Kiln).
(*G*) 9 A.M. Jackson Bros., Ltd., Knottingley, Glass Works. 10:30 A.M. John Lumb & Co., Castleford, Glass Works.
9 A.M. Beatson & Clark Ltd., Rotherham. Medical Glass. 10 A.M. Wood Bros., Barnsley, Glass Works. 11 A.M. Redfearn Bros., Ltd., Barnsley, Glass Works.
12:30 P.M., lunch at Queens' Hotel, Leeds.
3 P.M. Hailwood & Ackroyd Ltd., Glass Works, Morley.
Glasses for miners lamps and decorated glass; lunch.
(*H*) visited Leeds Fireclay Co's. terra cotta plant in the afternoon.

FIG. 4.—One-third of the party at an old mill at Versailles. (May 31.)

Lunch at Leeds Old French Restaurant.
Evening—Farewell entertainment and refreshments at Royal Victoria Station Hotel.

June 30 Left Sheffield 11:40 A.M. for Southampton. Arrived 5:30 P.M. Dinner, South Western Hotel.
Boarded "Tuscania" at 9:30 P.M. Sailed 11 P.M.

NEW MEMBERS RECEIVED FROM JUNE 1 TO JULY 1

PERSONAL

Richard S. Bicknell, 21 Bergen Place, Red Bank, N. J., Manager, Isolantite Co. of America, Inc.

Zeno W. M. Deurvorst, 26 Park Vronestein, Voorburg, Holland, Manager, Van Berkel Enameling Plants.

Charles B. Lawler, 916 Crescent Drive, Beverly Hills, Calif., Gladding, McBean, & Co.

Angel Moreno, Cerámica Riojana, Espeña-Logroño, Director-General, Fábricas de ladrillos, macetas; de azulejos, de re Fractario y de Terra Cotta.

Henry T. Ritter, So. Rockwood, Mich., Superintendent.

E. Schaidhauf, Kempten, Allgäu, Germany, Director, Electro-Silunebr-werk, Kempton A.-G.

Walter H. Schotts, 468 Vermont Place, Columbus, Ohio, Ceramic Engineer, Harrop Ceramic Service Co.

John Franklin Shepherd, 2021 Hudson Ave., Norwood, Ohio, Ohio Neon Lamp Corp., Cincinnati, Ohio.

Herbert J. Sissons, 6th Street, Redcliff, Alberta, Can., Managing Director, Redcliff Pressed Brick Co., Ltd.

STUDENT

William E. Budge, Univ. Sta., Grand Forks, N. Dak.

G. H. Wormhoudt, Iowa State College, Ames. Iowa.

Membership Workers' Record

PERSONAL		STUDENT	
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Howells Frechette	1	J. D. Tetrick	1
J. E. Hansen	1		
Roy Lacy	1	Total	2
W. F. Steger	1		
A. S. Watts	1	Grand Total	11
Office	3		
	9		

NOTES AND NEWS

W. J. SERRILL HEADS INDUSTRIAL STANDARDIZATION MOVEMENT

The election of William J. Serrill, Assistant General Manager of the United Gas Improvement Company of Philadelphia, to the chairmanship of the American Engineering Standards Committee is announced by the Committee. Mr. Serrill succeeds C. E. Skinner of the Westinghouse Electric and Manufacturing Company who has been chairman of the Standards Committee for the past three years, during which the national standardization activities of the Committee have doubled in volume.

W. J. SERRILL

Mr. Serrill has been prominent in standardization activities in the gas industry, and as representative of the American Gas Association he has been identified with the national standardization movement for several years. The vice chairman during

the coming year will be Cloyd M. Chapman, engineering specialist of New York City and representative of the American Society of Mechanical Engineers.

The members of the executive committee which will serve under Mr. Serrill during the coming year and the organizations which they represent are:

Samuel R. Bishop,	American Institute of Architects
Collins P. Bliss,	American Society of Mechanical Engineers
G. K. Burgess,	U. S. Department of Commerce
J. F. Callbreath,	American Mining Congress
J. A. Capp,	American Society for Testing Materials
C. F. Clarkson,	Society of Automotive Engineers
W. C. Cushing,	American Railway Association
W. A. E. Doying,	Panama Canal
Nathan C. Grover,	U. S. Department of the Interior
John Halligan, Jr.,	U. S. Navy Department
F. W. Kelley,	Portland Cement Association
T. H. MacDonald,	U. S. Department of Agriculture
G. L. Markland, Jr.,	American Gear Manufacturers Association
A. C. Morrison,	Gas Group
S. L. Nicholson,	National Electrical Manufacturers Assn.
J. C. Parker,	American Institute of Electrical Engineers
Leonard Peckitt,	Cast Iron Pipe Research Association
H. H. Quimby,	American Society of Civil Engineers
Henry L. Rice,	U. S. War Department
F. L. Rhodes,	Telephone Group
S. G. Rhodes,	Electric Light and Power Group
C. F. W. Rys,	American Association of Steel Manufacturers
C. E. Skinner,	American Institute of Electrical Engrs.
A. R. Small,	Fire Protection Group
A. A. Stevenson,	American Society for Testing Materials
Ethelbert Stewart,	U. S. Department of Labor
G. C. Stone,	American Institute of Mechanical Engrs.
A. W. Whitney,	Safety Group

A. E. S. C. CHANGES PROCEDURE TO SPEED NATIONAL STANDARDIZATION

Extensive revision of its rules of procedure to speed industrial standardization work on a national basis, is announced by the American Engineering Standards Committee. The chief object in broadening the procedure has been to make it so flexible that it may easily fit all of the varied conditions to be met in the wide range of industrial subjects covered by the Committee's work. The revision is based upon the experience of the Standards Committee during its nine years of activity as a national standardizing body.

Three important changes are made in the procedure. Heretofore, each sectional committee (essentially a joint committee composed of representatives of the various groups interested in the particular work in hand) has acted under the administrative support and direction of one or more of the interested bodies, who are termed sponsors. A sectional committee may now operate autonomously, reporting directly to the A.E.S.C.; or it may act under sponsors as before. The second change recognizes "proprietary" standards and makes possible the revision of such standards within a single organization on condition that it be shown that a standard is acceptable to the groups concerned. This method is particularly applicable to highly specialized fields in which the standard of an organization has already achieved a position of recognized eminence. The third change provides for very simple cases. The approval of standards under such cases is based upon the action of a conference followed by written acceptances of the interested groups.

The revised procedure states that the different methods are founded on the principle that the basic test to be applied in all cases is the fact of the assent, affirmatively ex-

pressed, of the groups having substantial interest in the standard. Such groups have an inherent right to representation on the body dealing with the subject-matter of the standard, but it is not essential that this right be exercised.

Steps in Development of a Standard by a Sectional Committee

The steps in the development on revision of a standard by a sectional committee are:

(1) Standardization proposed by responsible body.
(2) General conference called by A.E.S.C. to consider proposal and to decide whether the work shall be done; if so, whether the sectional committee shall operate under a sponsor or autonomously.
(3) Recommendation of conference acted upon by A.E.S.C.
(4) A sectional committee is organized.
(5) The makeup and personnel of sectional committee approved by the A.E.S.C.
(6) Standard drafted by sectional committee.
(7) The draft standard published or circulated for criticism.
(8) Proposed standard approved by sectional committee by letter ballot.
(9) Proposed standard approved by sponsor, if there be a sponsor, or formally endorsed by at least one coöperating body if the sectional committee is autonomous.
(10) Standard approved by A.E.S.C.
(11) Standard published by sponsor, or by the A.E.S.C. if sectional committee is autonomous.

Steps in Approval of Existing or Proprietary Standards

(1) An existing or a proprietary standard submitted to A.E.S.C. for approval by a responsible body.
(2) Investigation of facts regarding consensus through A.E.S.C. agencies; or the development of the acceptability of the standard through a representational committee.
(3) Standard approved by A.E.S.C.
(4) Standard published.

Steps in the Development of a Standard by General Acceptance

(1) Standardization proposed by a responsible body.
(2) Survey of field made, and draft standard produced by working committee.
(3) Draft standard considered by general conference.
(4) Proposed standard formally accepted by groups concerned.
(5) Standard approved by A.E.S.C.
(6) Standard published.

The governing authority of the American Engineering Standards Committee is at present vested in 63 men representing 36 national organizations, industrial, technical and governmental. About 350 national organizations are officially coöperating in the work, with 2100 individuals engaged on various committees. Up to the present time, 111 national standards have been approved, and 164 additional projects representing almost all branches of industry are under way.

ENAMEL INVESTIGATION AT ILLINOIS

The Utilities Research Commission which consists of representatives of the following utilities companies: Commonwealth Edison Company; Middle West Utilities Company; Public Service Company; Peoples Gas Light and Coke Company; Chicago North Shore and Milwaukee R. R. Company; Chicago Rapid Transit Company; has made a grant of funds to the University of Illinois for the investigation of the effect of the products of combustion on the quality of vitreous enamels applied on ferrous metals. This investigation is to be carried on by the Department of Ceramic Engineering, University of Illinois, Urbana, Illinois. The funds available for this year are $7000.00.

CALENDAR OF CONVENTIONS

American Assn. for Advancement of Science	Dec. 27–Jan. 2, 1929	New York City
AMERICAN CERAMIC SOCIETY		
(Annual Meeting)	February 4-9, 1929	Chicago, Ill.
(Pacific-Northwest Section)	Aug. 31–Sept. 1	Yakima, Wash.
American Chemical Society	Sept. 10–15	Swampscott, Mass.
American Concrete Institute		
(Annual Meeting)	Feb. 12–14, 1929	Detroit, Mich.
American Electrochemical Soc.		
(Fall Meeting)	Sept. 20–22	Charleston-Huntington, W. Va.
American Institute of Chemical Engrs.		
Industrial Tour of Canada and U. S.	Aug. 18–Sept. 2	
Amer. Inst. Min. and Met. Engrs.		
(Regional)	Aug. 29–31	Boston, Mass.
American Gas Assn.		
(Annual Meeting)	Oct. 8–12	Atlantic City, N. J.
American Soc. of Mechanical Engrs.		
(Summer Meeting)	Aug. 27–30	St. Paul-Minneapolis
(Regional)	Oct. 1–3	Boston, Mass.
(Annual Meeting)	Dec. 3–7	New York City
(Second Natl. Fuels Meeting)	Sept. 17–20	Cleveland, Ohio
American Soc. for Steel Treating		
(Annual Meeting)	Oct. 8–12	Philadelphia, Pa.
(Semi-Annual)	Jan. 14–18, 1929	Los Angeles, Calif.
American Zinc Institute	April 15–17, 1929	St. Louis, Mo.
Assn. of Scientific Apparatus Makers of America	May 3, 1929	Atlantic City, N. J.
The Mining Congress	Sept. 10–13	Los Angeles, Calif.
National Assn. of Manufacturers	Oct. 22–25	New York City
Natl. Assn. of Mfgrs. of Heating and Cooking Appliances	May 8–9, 1929	New York City
Natl. Exposition of Power & Mechanical Engrs.	December 3–8	New York City
Natl. Glass Distributors Assn.	Dec. 4–5	Pittsburgh, Pa.
Optical Society of America	Nov. 1–3	Washington, D. C.
Safety Congress	Oct. 1–5	New York City
Taylor Society	Dec. 5–8	New York City

ADDITIONAL NOTES ON THE CERAMIC TOUR

June 18. A small group lunched at the American Chamber of Commerce in Berlin.

June 18. Geo. Denison, W. H. Crume, and John Kauffman visited the plant of the Berliner Kalksanstein Fabriken, Herr Guttman, about thirty miles from the center of Berlin. This factory is the largest individual sand-lime brick factory in Germany and produces 200,000,000 of the large size german brick per year. In addition to their own manufacture they control the sales of the other sand-lime brick factories in the Berlin district.

The above plant, while one of the oldest is very complete and equipped with many labor-saving devices. They have their own sand supply, adjacent to the factory, their own limestone, together with their own lime kilns, and approximately 18 dry presses in operation. Their plant is situated on a navigable stream and all their products are shipped by water. They have not only their own loading box, but own their own fleet of power barges, and a complete shipyard for keeping their barges in condition. They have their own steam plant, and operate their machinery with their steam engine, and also generate electricity for their auxiliary equipment. Their tram cars are hauled to the docks and storage by electric trolley locomotives. The plant was operating at full capacity, and had practically no accumulated stock on hand.

June 22. A group of Americans visited the stained glass studios of James Powell in London.

June 23. W. F. Higgins of Williams Higgins & Son Brick Manufacturers, Manchester, took a party of heavy clay products men to Colchester, where they were delightfully received by Jas. G. Anderson, Manager, Hythe Works of Motor Products, Ltd., manufacturing insulating brick and tile. This was one of the most modern plants seen on the tour. By courtesy of Colchester Council the American guests were shown the newly excavated Roman bath, covering a large acreage, and included extensive brick work built 2000 years ago.

W. F. Higgins as one of the hosts gave freely of his time, money, and influence to entertain these guests.

June 25. Some of the ladies after the luncheon at the Chamber of Commerce in Birmingham were taken out to visit the ruins of the Roman Baths in Litchfield and were entertained at tea by Mr. and Mrs. Park and Lady Park.

June 26. The heavy clay products men inspected clay working machinery at the plant of Sutcliffe, Speakman, & Co., Ltd. at Leigh.

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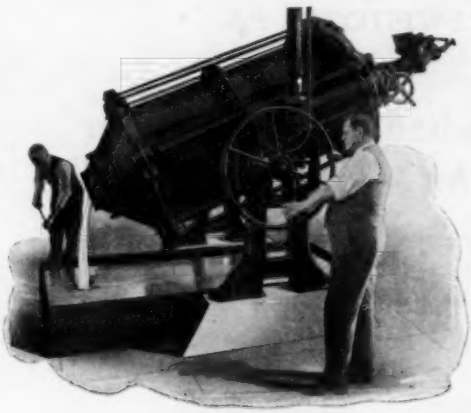

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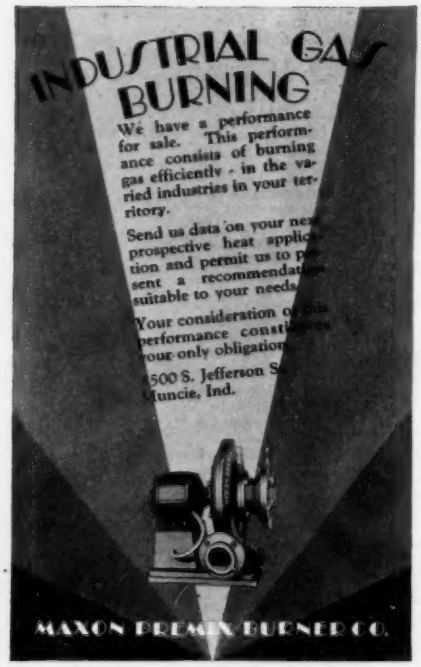
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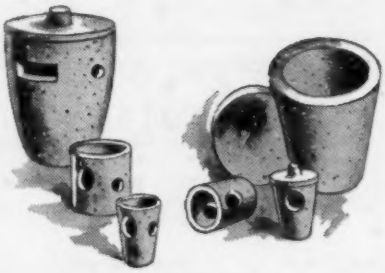

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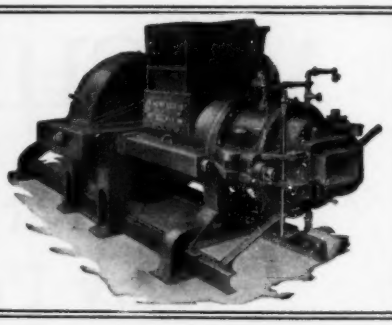

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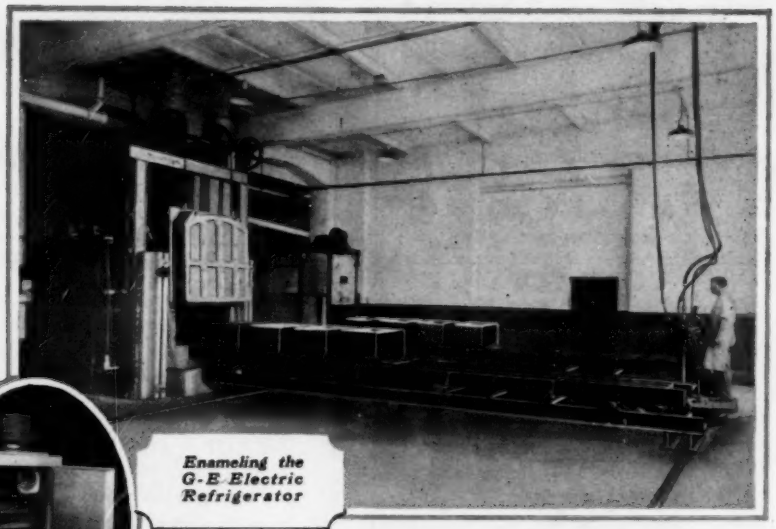

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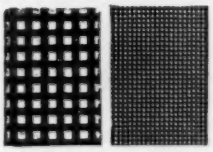
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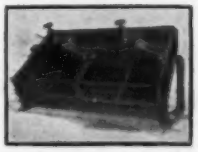

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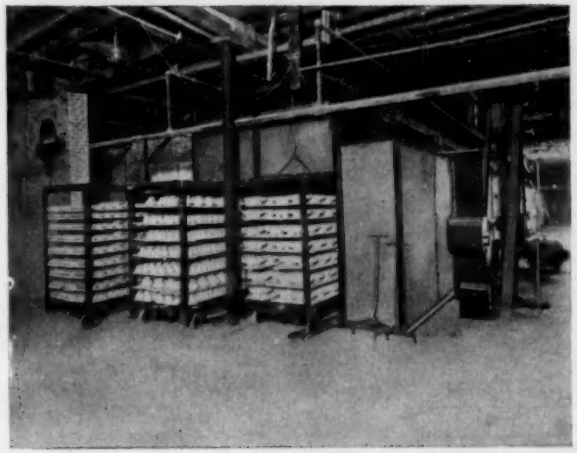

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